Development of Smart Execution Process Model and implementation of it on a pilot project in a Power System Organization in UAE

تطوير نموذج تنفيذ عملية الذكيه و استخدام النموذج فى اداره مشروع فى بشكل عينة فى وحده الاعمال ب س د فى شركه ا ب ب فرع الامارات العربيه المتحده.

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1. Abstract

The research presents the process development in a project based organization (i.e. PSN business unit at ABB UAE). The researcher reviews and analyse the existing management processes with consideration of relevant literature. A new integrated process model would be developed (i.e. smart execution process model) and the existing management processes would be redesigned consequently. The newly developed processes would be implemented in a pilot project and the result would be presented and compared with previous project results. The research findings shows that early involvement of project management team in sales stage, application of gate process model (i.e. having gate review meeting with involvement of all project team members) and knowledge management (i.e. usage of lesson learned from previous projects) in project organization could improve the project execution in terms of cost and time.

البحث يقدم عملية التطوير فی الموسسات علی اساس مشروع (وحده الاعمال ب س د فی شرکه ا ب ب فرع الامارات العربيه المتحده). الباحث يلاحض و يحلل اداره العمليه الموجوده مع نظر علی البحوث القائمة و المشابة. سيتم تعيين و وضع نموذج مندمج جديد (نموذج تنفيذ عمليه الذکيه) و بنا علی ذالک سيتم اعادة تصميم ادراه العمليه الحاليه. ستنفذ النموذج جديد فی اداره مشروع عينة وسيقاس نتايج مع اداراة المشروع فی حاله السابقة. النتايج تظهر أن مشارکة مبکرة فريق تنفيذ المشروع فی مرحلة المناقصة المشروع، تطبيقق نموذج عملية بوابة (أی اجتماع مع اشراک جميع اعضاء فريق المشروع) و ادارة المعرفة (أی استخدام تجربيات من مشاريع السابقة) فی ادارة المشروع يحسن تنفيذ المشروع من حيث التکلفة و الوقت.

2. Introduction

2.1 Background

Nowadays, aggressive business environment has forced companies to assure customers who demand escalating product diversity, lower cost, better quality and faster response. Therefore, offering higher manufactured goods quality is the main necessity to gain global market share (Wu et al. 2009). Conventionally, high tech firms addressed this need with reduction of the manufacturing time of products. But simply reduction of product manufacturing time alone rather than considerations of customer satisfaction factor, would not lead projects in efficient way. To improve the suitability of project conclusion, it is important to first understand the process (i.e. how a project starts, evolves, develops, grows or terminates). Such perceptive requires awareness of the underlying generative mechanisms that cause product enlargement events to occur in organizations and particular conditions or contingencies during which these mechanisms work. (Verma et al. 2010).

A process can be seen as a value sequence by its involvement to creation or delivery of a product or service, and each step in a process should add worth to the taking place step (Hunt 1996). At the same time a process as a collection of activities that take inputs and create output (i.e. added value to customer) (Hammer and Champy 1993) could fail when there is no measurement, no control, no maintenance and no incremental improvement on it (Merwe 2002).

Business processes are distinct as “a series of steps designed to produce a product or service” and, most processes are cross-functional, across the white space between the boxes on the organization charts (Rummler 1995) and could be categorized in three categories: (i) customer processes – which result in product and services that are received by organization’s external customer, (ii) administrative processes or other processes – which are undetectable to the outer customers but necessary to the efficient management of business, and (iii) managing processes – which include procedures of management to support the business processes like goal setting, day-to day planning, performance feedback, rewards and resource allocations (Merwe 2002).

Processes have become a core competency factor in today's rapidly changing business environment (Han and Park 2009). In an responsive and flexible endeavor structure, process is a core element of business operations. Therefore, business process utilizes knowledge during the process execution; data feeds performance for higher accomplishment and performance leads a process to achieve business goals. sequentially, a business process measures act through metrics; performance feeds back knowledge for the later employ of that knowledge drives the process to develop routine operations.

So, process development should be viewed as a planned function for getting a competitive boundary and as such explicit measure should be in place to create an environment that is conductive to successful performance (Lu and Botha 2005). Building capabilities in process development is not easy task for managers, as research, emergent and implement new process occurs in a dynamic atmosphere (Pisano 1997).

Thus, a process is "a structured group of related actions that work together to produce an outcome of value" (Hammer 2001). A system is "an incorporated set of essentials that complete a defined objective" (INCOSE, 2007). A process is a kind of system, where the elements are usually activities (work to be done, decision to be made, etc.) and the integrating relations are the activities' interdependencies (Browning et al. 2006; Crowston, 2003). Process reengineering then means to change the current processes to redesigned processes which mean formative the wastes and reworks of an existing process in order to establish a better performing process. In most traditional organizations, product development is a sequential process (Prasad et al. 1998).

In a challenge to better realize processes, researchers have developed several system-oriented models that treat the process as a network of interconnected activities (Browning and Ramasesh, 2007). in fact, process models provide one opportunity to organize a particular source of information (Browning et al. 2006) perhaps even the best one (Crowston, 2003).

However, models that attempt to include all about a project have been substantial to construct, sustain, comprehend and apply. Also, it has been noted that managers have a preference of straightforward models to more pragmatic ones (Little, 1970). Therefore, a new approach would appear to be desired that could concurrently give managers fullness, combination and harmonization while retaining simplicity and focus.

Once a new process is defined, the next step is validation of model in order to use in entire organization. The model has to be fine validated using acknowledged fitness model confirmation techniques like piloting or simulation (Naquin and Holton 2003). Prototyping is a kind of normative tool which could be presented as a way to effectively accelerate the development process and afford the user with experience in operating a system before a main progress effort is undertaken (Paddock 1986).

2.2 Problem Statement

Power System (PS) division of ABB UAE Company is divided into two sub divisions Power System Substations (PSS) – which is running turnkey High Voltage Substation projects (i.e. the high voltage substation projects as a main contractor with utilities like FEWA, DEWA, ADEWA and AADC or construction companies in UAE, like TATWEER, EMAL and etc.) and Power System Network (PSN) – which include for Business Units (i.e. 2875, 2877, 2818 and 2850). PSN – Business Unit (BU) is running protection and control automation systems projects of high voltage substations which is a main part of a high voltage substation (i.e. protection panels and substation control and monitoring systems project as a sub-contractor for main contractors inside ABB like PSS or third parties like Larsen &Toubro Limited Company, Emirates Technical Associations and etc.

The scope of work of projects in PSN-BU include design, manufacturing, factory test, delivery, test & commissioning at site of substation controlling and monitoring system (SCMS) and protection panels (PP). Projects in PSN-BU close with cost overrun (i.e. due to number of reworks in different stages of project execution in comparison to contractual amounts) and customer less satisfaction due to longer delivery time (i.e. in compare with contractual dates). Consequently the reduction in market share according to annual BU assessment reports; the markets share of PSN in UAE was 58% in 2007, 33% in 2008 and 37% in 2009.

According to reports the order delivery time to customer was about 356 days (i.e. about 51 weeks or 13 months) for a complete set of control and protection panels and SCSM of a typical 132kV substation (i.e. 12 panesl). Panel manufacturing lead time (i.e. assembly, wiring the panel, preliminary test and factory acceptance test) was about 2 months.

The tender loss analysis reports, which are outcome of sales management quarter review meetings, highlighted that higher finished product price and longer lead time in compare to competitors are major reasons to lose the market share. In addition, the finished goods' price in ABB UAE is usually higher than it's internal (i.e. ABB sister companies and same business unit in other countries or regions. Like; ABB Check Republic, ABB Saudi Arabia or ABB India) even though, they are producing the same type of panels with same range of protection relays only in different regions.

Consideration of less market share in last three years, costs overruns in the projects appear as cost of poor quality. And consequently negative growth of projects' gross margins' which would be effect the local business unit's profitability in higher level. Furthermore, increasing of the customer technical demands in power industry here in UAE, if the management would not pay attention to problem in depth, ABB UAE Company should stop the operation of business in PSN business unit in close future. Since, they would not be able to catch more business opportunities and they could not survive in the competitive market.

The investigations about the mentioned problem indicated that the existing processes need to be analysed and redesigned since the raw material and finished goods are all the same in all ABB panel manufacturer business units. Thus, this research will focus on PSN Business Unit processes development in ABB UAE Company which is running large numbers of projects currently.

2.3 Research Aim and Objectives

The aim of this research is, firstly, to develop customized process model which will be Smart Execution (SE) in PSN BU project organization based on analysis on existing processes and validation of that model in a pilot project. The next would be implementation of the validated model in entire business unit, in order to access future business opportunities (i.e. improvement in projects' lead time and market share).

In order to achieve this aim, the research has the following objectives;

1- Evaluate the existing project management process (i.e. sales, design/ engineering, manufacturing, test & commissioning) in PSN Business Unit of ABB UAE and identification of weak points of those processes based on reviewed literature.

2- Develop an integrated model to cover all requirements of business unit based on literature reviewed and existing processes.

3- Validate the process usefulness by application of defined process on one project and analyse the results and compare with results of existing processes application.

2.4 Research scope

This research will focus on ABB UAE Company with over 250 employees in PSN BU which is running collection of High Voltage Substation Automation projects.

2.5 Research Organization

In the following section the collected literature relevant to process development in project organization, product development processes, redesign and optimization of process will be reviewed, with consideration of product, service and project – since the project deliverables in ABB UAE - PSN Business Unit are combination of product and service in order to introduce a compatible process model which could cover all functional requirements of PSN project organization with reference to the existing processes.

The next sections will present; description of research occurrence (i.e. methodology of research) and analysis (i.e. collected historical data relevant to previous projects will be presented, the existing management processes will be presented and analysed with reference to reviewed literature and the weak points will be highlighted and an integrated process model will be developed) then the collected data of pilot project will be presented (i.e. the result of pilot project which have been managed through Smart execution process model and will be compared to other projects) in order to validate the model and at the end of that chapter research findings will be presented.

Finally conclusion will show the research results.

3. Literature Review

In the field of operation/ engineering, hard work to advance the performance of product/ process development has similar importance as efficiency and quality development received recently (Lu and Botha 2005). Also, with intensified globalization, the effective process management of an organization became ever more important. Many factors such as; the necessitate for information convey, quick decision making, adjust to change in demand, more global competitors and demands for shorter cycle times (Smichi-Levi et al. 2000), are demanding the success and endurance of companies (Ko et al. 2009). Moreover, the complexity of an uncertain environment demands more effectual alliance, more discussion and communication among decision makers with veracity of knowledge (Miller and Lee 2001).

Efficiency is about doing things right and effectiveness is about doing right things (Drucker, 1974), are significant to business successes and apparently simple concepts to grasp, are strongly linked to performance and productivity. Scholars have long searched for ways to quantify efficiency and effectiveness using various perspectives and different methods. And, modern era seems to have enlarged marketplace and business dynamics, with ever-increasing necessities for quicker, more fundamental improvement and ever-increasing efficiency in development and effectiveness of the manufactured goods. Efficiency improvement can be pursued in several ways, employ different perspectives on change (Kling, 2006)

The combined optimization of both the social and the technical systems in an organization is innermost to the socio-technical system approach to design work and organizational development (OD) which is part of socio-technical development. Work design means the organizing of tasks in order to transform inputs to outputs by technical and social subsystems with concern of the organizational circumstances. Work design, could increase productivity through better utilization of human resources and capital equipment, as well as improved quality of work life according to (Patnayakuni and Rupple 2010). So, development process in an organization can be conceived as a work system (Alter, 1999) and utilize of organizational development techniques could increase the probability of systems’ success as well (Nikolas, 1979).

3. Literature Review

As mentioned earlier, OD techniques and the socio-technical systems (STS) approach share an idea which is desirable to continue in the system development task along with two dimensions; technical and social (Bostrom and Heinen, 1977a & b). STS advocate a three phase approach to the system development task. Phase I is the strategic design process and its purpose to make the goals and accountability for the project explicit. Phase II is the socio-technical system design process which divides into four parts; technical system analysis, social system, analysis, design/ redesign phase and management of the change process. The final phase, phase III is continuing process which involves steady monitoring and modification of the new system to guarantee that it meets its goals (Paddock, 1986).

The approaches and tools used to develop systems are often key factors in their final success. They can be divided into several categories. Like; conventional, evocative tools, normative tools, Socio – technical developments, process mechanization and substitute methodologies. The traditional approach is based on system development life cycle (SDLC) which includes crisis definition, analysing the existing system, design information, technology & processing requirements, development the system, test the system and validate the system, implement, assess and maintain the implemented system (Paddock, 1986).

Miller and Lee (2001) believe that information dispensation in the form of persevering scanning of the ecological, intellectual and systematic analysis of problems or opportunities can be helpful for companies. Scanning can expose important client requirements, market intimidation and opportunities as well as areas of strategy requiring improvement. So, analysis of circumstances inside and outside a company decrease chances of making errors and improves the excellence of the options considered and the choice made while, a qualification for undertaking any fundamental change processes for achieving success in globalization is the need for flexibility and compliance to change. This is particularly important for comparatively successful companies as they may not feel the necessity or see the advantage of change (Kumar Dey 1999).

Also, in market characterized for aggressive change, hesitation and communications, management should have flexibility to amend the operation strategy to exploit favourable future chances or to minimize losses (Santos and Pamplona 2005). In fact, no company exists whose management does not want an organization flexible sufficient to adjust rapidly to change market circumstances, bend enough to beat any competitor's price, innovative enough to keep its goods and service technologically fresh, and enthusiastic enough to convey maximum quality and client service (Hammer, 1994).

Since understanding of customer/ user desires throughout the company is extremely suggested to ensure that the concluding product matches the customer requirements (Nightingale 2000), and companies try to function at the lowest potential cost in a spirited market to produce considerable profit, so, in many industries, firms are looking for to improve quality and trim down the cost of goods (Petersen et al. 2005). So, the necessity to focus on customer is crucial for redesigning the business in the best manner. But, former to any expansion; one must create cost objectives and perform value – engineering analysis, so that a amalgamation of quality, functionality and price desired by the clients can be integrated to appraise the profit achievability (Norton and Kaplan 1997).

3. Literature Review

3.1 What is a Process and why should be developed?

Organizations now give the impression to position on four new supports; strategy that aims to pleasure customers, configuration, process that guide to the eventual of efficiency and projects, which influence and depend on one another in this era of rapid use (Merwe, 2002).

Smith (1981) mentioned that, the technology of the industrial rebellion had created extraordinary occasions for companies to enlarge workers' productivity and thus decrease the cost of products not by small percentages, which one might attain by persuading and artisan to work a little quicker but by orders of scale. Merwe (2002) also pointed that, in the last 20 years, process metaphors have been converted into the source for codifying and corresponding definite managerial comprehension about what work to do and how to do it.

Processes are important elements of modern systems engineering (SE) theory and practice. In addition, to their use in the engineering of systems, they are at the basis of approaches such as project management, total quality management (TQM), lean, six sigma, reengineering, ISO 9000, CMMI^{SM}, etc. however, the term "process" and the tasks most accurately linked with process definition, fulfilment and development are some of the most "complexity tacit" concepts around (Browning et al. 2006).

The educational press dictionary of science and technology describes a process as follows; "process- to perform a series of activities or the series itself". In specific utilize like a systemic procedures designed to perform some actions, engineering a continuous or periodic series of actions organised and accomplished to attain an end results. In the revised edition (1989) the American national standard for industrial engineering vocabulary of process is defined as "a systemic sequence of operations to produce a specific result" (Merwe, 2002).

According to Hammer (2001), a process is "an organized set of linked activities that work together to create a result of value" or "a network of customer-supplier associations and commitments that make activities to produce results of value." Thus, an individual would be able to think of the work on any project or program as a large process. So, process models are classically activity network models (Browning et al. 2006)

3. Literature Review

A system consists of elements and connections, a process, as a kind of system, include of both activities and deliverables, while the deliverables have a tendency to be deemphasized in many of normal views. As with any system, any process is part of (i.e. can be thought of as an activity within) a larger processes, and each activity in a process may itself be viewed as a process (and further decayed into lower –level activities). Thus, the terms “process” and “activity” are observer-dependent and often exchangeable. The activities in a process and their interaction help establish the structural design of that process (Browning and Eppinger, 2002). Process structural design refers to the structure of activities, their relations and the principles and rules prevailing their design and evolution (Browning, 2009).

The need for process explanation was primarily observed in the processes associated with new services. The problem within the new services was a more consumption of resources than initially estimated, overruns of a schedule and conflicts over the responsibilities. It was realized that we open a door for ongoing changes within the processes to improve the existing conditions and development of the services. “If it’s broke, fix it, is not broke, improve it…. But never leave it alone” (Hill, 1998). Such a move in the company culture leads to continuous improvement of definitions for processes (Abdomerovic and Blakemore, 2002).

Merwe (2002) said that business processes manage by three rules; there ought to be a comprehensible purpose to the process, which is the goal to be achieved, incremental upgrading has to occur during the process of getting the goal and each incremental improvement should be a mission which involves people. And, he stated “one best way” of doing things theory based on four pillars: division of labour, functional processes, structure of control. So, due to globalization and ever shorter change cycle’s they must improve gradually more rapidly their products and, services technologies and organization according to customer requirements and optimize their efficiency, effectiveness and reduce total fabrication costs (Stoll and Laner, 2010).

Kumar and Strehlow (2004) presented a successful systematic organizational improvement attempt at a mid-size electronics components manufacturer using process mapping and teamwork. A cross-functional team was responsible to work on a business process development, particularly targeting the sales process (i.e. as a bottleneck operation). It was planned not only to improve the quoting process, but also to force the amplification of the responsibilities of the new engineering group and thus move them nearer to incorporation with fabrication function. throughout, getting together representatives of all the functional units involved in the process then reviewing and analysing the current process, Searching for ways to reduce bidding and sales times, optimizing the process and setting goals for it, and preparing an action plan that included the group's recommendations.

Morin (1985) stated that**,** Effective management of technological innovation in a company desires enlargement of following functions; to take stock – the inventory of technological capacity of the company relative to their competitors, to assess – the classification and delimiting of the technological fields of the company in different time frames (i.e. short and long term) through the explanation of an outlook vision of the technological requirements, according business strategy, to optimise – the adjustment of a successful organization for the growth and utilisation of technologies, to enrich – the development of technological capacity of the company through the enrichment of its technological sourcing, to safeguard – the management of the industrial property and copyright and to monitor – include the functions like technology watch and technology intelligence

Lu and Botha (2005) Process development is part of the product realisation process. Process development objectives which supports overall goal of product realisation are enabled by (1) intra-functional enablers within the process development function (i.e. modular design, activity overlapping, development methods, development process and early investment); (2) inter-functional enablers through interrelating with product design, process execution and suppliers (i.e. communication environment, cross-functional teams, conflict resolution, supplier development and support from product design); and (3) learning enablers by aligning experimentation and mode with stages of process knowledge and association with process execution.

Pisano (1997) argues, process development is precisely complicated and organizationally complex activity in its own right, and operates in much richer context than is usually portrayed in the concurrent engineering literature. Process development can provide strategic advantage. Therefore, there is a need to develop a framework addressing the gap in knowledge concerning process development. There are natural difficulties in developing a framework due to fact that process development is either overlooked or miscellaneous with product development in existing empirical and theoretical reports (Lu and Botha 2005).Despite the technical difficulties and increasing competitive importance of process development studies focusing on process development remain very few (Pisano, 1997; Pisano and Wheelwright, 1995).

3.2 Process Analysis, Development or Reengineering

Organizations commit to analyse their organization by the lens of their lived processes. They pose themselves “how can we use new technology to optimize our processes” instead of “how can we do something new with the technology automation instead innovation” (Hammer, 1996). Thus we need a holistic, systematic approach, which is leaning to the organization objectives and promote a continuously development to fulfil customer requirements and ambient changes to guarantee a sustainable organizational development by increased efficiency, effectiveness and reduced costs (Stoll and Laner 2010).

So, In order to improve the process, it is necessary to evaluate the performance of the existing process. Performance evaluation means measuring the performance of a process. Many researchers have considered ‘time’ or ‘cost’ as performance measure (Sum, 1992; Palmer and Korbly, L. 1991; Creese & Moore, 1990). Reduction in ‘time and ‘cost’ are actually the end goals of a CE process (Prasad et al. 1998). Because, if firms engage only the experimentation and exploration without consideration of their existing knowledge basis, will likely to suffer from the cost of experimentation without gaining many benefits (Verma et al. 2010).

Many researchers highlighted the importance of detail analysis of existing process like; (Abdomerovic and Blakemore, 2002; Ko et al. 2009) in order to identification of current strengths and limitations of each process. Also, a survey in some Cuban companies with the final objective of the identification of weaknesses of existing processes identified the areas which can be developed. Since, the diagnostic procedure indicates a need for conceptual model to underpin the management of technological innovation and as well as procedures for its organization and operation in the manufacturing units (Vinas et al. 2001).

Stoll and Laner (2010) also believe that, the first step should be setting of objectives. For establishing the vision, goals and strategies collaborators including managers (i.e. all organization/ project stakeholder requirements and expectations) should be considered. The next step is process analysing and process improvement. Thereby, Process analysing should be done with considering all organizational processes beginning from the management process, all business processes including the development and design processes and as well as all supporting processes, resources processes and optimization processes with consideration of different aspects like; quality and so on. Since, all processes analysed, and then we should optimize the regarding the established organizational objectives and then efficiency and effectiveness can be externalized.

As we already mentioned, according to Lu and Botha (2005), the process design decodes product design into the technical understanding, organizational competencies and operating processes to generate the product (Pisano, 1997). And, the process developer desires to design a factory system that fully engage all workers in the operations strategy, operates optimally in terms of costs and inventory, and that integrates capabilities with suppliers (Whitney, 1988). So, Process reengineering should be carried out sequentially; identification of processes, selection of key elements, determining the areas of improvement and deriving the reengineered process. The results often are extensively away of existing structures and methods which cause replacement with new systems. Such new systems are also strengthened and crosses all the old boundaries. (Kumar Dey, 1999).

Devenport and Short (1990) have defined business process reengineering, as the analysis and design of process within the organizations. It is to rethink, restructure and streamline the business process methods of working, management systems and external relationships through which we create and deliver value. But, it could be a challenge for an organization since, reengineering of processes - which requires the perfect marriage of technical and human elements, requires drastic paradigm shifts which may take a considerable time for adaption in the existing systems, or new processes may require application of some new tools and techniques which may cause problems during adaption in the existing methods, or reengineered processes demand the application of IT tools, which may require additional capital investment (Kumar Dey, 1999).

Abdomerovic and Blakemore (2002), a process reengineering and generic processes development should ongoing work undertaken by individuals with special skills in order to be understood and operated by numbers of project participants. So, once a planned objective achieved (i.e. process developed) it should be monitored and maintained continuously (i.e. should be evaluated periodically in base of established process and organizational measurement tools with including customer satisfactions, and consequently implement the necessary corrective, optimization or preventive actions) through, periodically internal/ external audits, feedback from stake holders, the collaboration with suppliers (Stoll and Laner, 2010).

3.3 Product Development Processes

The study of traditional product development originated from 1960’s and became an active topic at the end of 1980’s and the beginning of 1990’s. Product development victory in terms of time and innovation has contributed significantly to a firm’s competitiveness. In the recent literature we can find several models based on the lessons and guidelines for success in the product development process. Several authors including Wilson (1995), Bowen et al. (1994), McGrath (1996), Rosenau and Moran (1993) and Smith et al. (1995) have highlighted several common significant elements of product development projects. Speed to market, quality management, multifunctional teamwork, sense of commitment and a system approach, are proposed by most of these studies as key necessities for success in product development (March-Chorda et al. 2002)

Clarck and Fujimoto (1991) defined the activity of product development as the process to convert information from the market into information required to the fabrication of finished goods for commercial purposes and according to (Krishnan and Ulrich, 2001) Product development is the conversion of a market opportunity and a set of assumptions about product technology into a product available for trade. In order to deal with product diversity and market variety, companies should pay more attention to product processes development (Pisano and Wheelwright 1995).

Product development process management can classify with product development activities, observe and validate product development process, build integrated product process model, set up the checking method of product development process, establish the system of check and conflict resolution among activities, provide division support tool for product development process and design and so on (Zhong et al. 2005).

Tatikonda and Montoya-Weiss (2001) showed that the organizational process factors of process concurrency, procedure and flexibility are positively associated with achievement of operational outcome targets for product quality, unit cost and time to market which are key product development competencies of an organization. So, it is essential to achieve time compression and optimal performance (with respect to meeting customer and company interests, such as X-ability consideration) for the products' design and development (Prasad et al. 1998).

Concurrent engineering (CE) is a systematic approach for considering all aspects of a product's life cycle management including the integration of planning, design, production and related phase(Zhong et al. 2005), and its objective is to shorten the product development cycle, improve the product quality and reduce the product cost. In order to organize a cooperative team and direct its effort, it is necessary to model the enterprise process (Prasad et al. 1998).

With the predetermined study on Concurrent Engineering (CE) the accommodating product development, incorporated supporting atmosphere for simultaneous design and smart decision support system become the current hotspot. The integrated product development team for cooperative product development is made up designers who are working in different functional units and one team. Thus it can decrease the progress cost and improve product quality by resources of manufacturing and all kinds of data and experience of related designers (Zhong et al. 2005).

The traditional product development phases or tracks are often serial. In other words, the phases generally run in serial mode. In a traditional product development mode, the respective life-cycle engineers do their own work in phases and the information is passed serially on to the next department or group. In a traditional mode, each department works somehow independently of each other and the information is passed to the next department only after the completion of all of its assigned (department's) tasks. This passing of information between the two consecutive departments or groups is normally a one-time transfer. A backward pass is required when a rework or a revision on the main activity is desired or requested during the course of product development/ refinement. In a traditional process, main-activity represents the tasks for only one distinct phase.

More recently, advanced product density, increased competition, clients' demands for customization, reduced reaction times and bigger numbers of activities and amount of information to be managed have enlarged the requirement for a systematic approach to managing projects, especially large ones (i.e. programs).

3. Literature Review

Concurrent engineering and integrated product and process development (IPPD) have increased the overlap among PD activities, noticeably escalating the coordination challenge. Increased coordination with partners and suppliers has also contributed to increased complexity in contemporary PD projects (Browning et al. 2006)

Product risk is quantified in the planning phase as it is originated by the design and impacts on quality, time and cost in the implementation stage through processes (Merwe 2002). So, process performance is important as well as product success, pressurring the efficiency characteristic of the development process combined with the effectiveness feature of the product. Process performance is often measured as lead time and productivity Brown and Eisenhardt (1995).

Different authors distinguish efficiency quite in a different ways. Some maintain a principally internal focus on capability, whereas others advocate a more external center of attention on results and fulfilling external requirements, from clients or owners (Tipping, 1993). Which can be seen as the creation of required output at a alleged minimum cost, considered by ratio of quantity of resources spent to plan, whereas effectiveness can be seen a quantify of how closely an organization's productivity meets its goal and/or the customer's requirements (Schmidt and Finnigan, 1992). And, Kling (2006) distincts Productivity as 'the quality of being efficient and is a determinatin of the rate of production, output per unit input. Productivity and efficiency are frequently more or less synonymously. So, Product development efficiency is to large extent restricted internally, by the organization, while product effectiveness is determined relations between marketing, product development and other inter – as well as intra-organizational actors (Kling, 2006).

Browning et al. (2006) Key elements of processes have been used for systems development, or, generally, product (and service) development (PD). PD is an endeavour contains of the many, multi-functional activities done between defining a technology or market opportunity and starting production. The goal of PD is to create a "receipt" for production (Reinertsen, 1999). The reception must confirm to requirements stemming from customer or market requirements. It includes the product's components (i.e. bill of materials) and preparation path (i.e.

manufacturing, supply, distribution and support system). PD involves creativity and innovative and is nonlinear and iterative (kline, 1985)

Bessant and Francis (1997) Presented 6 key design elements in product development which are necessary for implementation of upgraded processes;

1- The need for a stage-gate system, a common perceptive of the new route through this and the criterion for “go/no go” decisions at each stage. This provides a configuration for the decision making elements in PD and ensures that active decisions are taken when resource commitment decision must be made.
2- The building of a product management (made up of appropriate directors, meeting regularly and if necessary on an ad hoc basis), to make the formal agreement decisions for progressing through the system. This elevates NPD to a higher level and ensures that commitment decisions are taken to sustain the strategic intent of the firm.
3- The classification of clear roles and responsibilities within the process, particularly hand-over product managers to project managers. This provides for the greater management of linkages – an early weak area in hierarchically based organizations.
4- The requirement for equilibrium between early taking part of downstream functions such as manufacture and fast-track decision making. These moderate the load or trying to communicate everything to everyone who could perhaps be involved at all times.
5- The need for a multi-track system to deal with with different kinds of new products, from simple variants on existing themes to completely deep-seated new concepts. This provides intrinsic flexibility, thereby reducing the risk that a demanding (and therefore costly) procedure is used for simple product enrichment which do not require an sophisticated decision making process.
6- A collective perceptive of the company’s competitive strengthens and its strategic focus.

As an example, Kling (2006) studied on efficiency enhancement at Ericsson, principal supplier telecommunication communications equipment. Ericsson, along with the whole industry, went throughout a main downturn in the early 2000s.

Revenues jumped down noticeably, turning former high profits into enormous losses over night. The company forced to take powerful action to radically and quickly decrease costs. This resulted in dramatic downsizing with decrease of the workforce in addition to outsourcing. The alteration was, by obligation, fast and implemented in a top-down approach, with little contribution by other members of the organization. And he has shown fruitfully implemented a corporative conversion and starting to see revenue escalation and move back into profits. Ericsson faced the challenge of delivering the same amount of product and services to the market with half of its past organization. This challenge called for key improvements to efficiency throughout the whole organization.

Moreover, if a company want to stay competitive, it has to work with its supply chain associates to improve the chain's entire performance. Thus, being the main process in the upstream chain and touching all areas of an organization, the purchasing function is taking an increasing significance. Thus supply chain management and the supplier (vendor) selection process is an issue that received comparatively great amount of attention in both academia and industry (Sanayei et al. 2010).

Petersen et al. (2005) presented the same, through case studies which were from USA and Japan like; automotive, electronics, computers, chemical, consumer products and semiconductor products companies who were successful at supplier integration, employed a systematic process. They suggested three forms of assessments are deemed to be necessary antecedents to successful supplier integration which are;

1- A comprehensive evaluation of the suppliers being well thought-out for contribution, principal to selection of suppliers with capabilities well-matched to the customers.
2- Supplier contribution and involvement in the appraisal of the technical component allied with the project (quality, consistency, functionality, etc.)
3- Supplier participation and contribution in the evaluation of the cost, schedule, and other business factors significant to the crucial accomplishment of the product development projects. Successful supplier incorporation efforts cannot be entered into without a full agreement on projects schedule,

engineering qualifications, cost drivers, pricing and other business variables in the contract.

Project management preserve to maintain the company strategy through product customization, quality and segregation, and can contribute to strategic development by providing competitive benefit. As organizations face rising pressure to achieve customer requirements in a cost-efficient way within ever-cutting timescales, the significance of project management enlarge in product development (Bryde, 1995), But, since the designers and managers have a hectic jobs (i.e. developing the product), they do not have time to build up process, in most cases of the experience, the product development is acquired passively rather than actively (Zhong et al. 2005).

Bowen et al. (1994) highlights seven important elements that any outstanding products development project should have in common: (1) recognize and look after the firms' core capabilities, (2) common vision generated by all numbers in the cross-functional team, (3) project leadership and organization, (4) ability to install the team with a sense of ownership and commitments, (5) ability to quickly learn and to reduce error and misinterpretation, (6) capability to move forward the company's performances and (7) capability to incorporate within projects following a system approach.

Rosenau and Moran (1993) provided a channel for success with project management tools to the product development process, put emphasis on speed to market, quality management and multifunctional teamwork. Likewise, the study by Himmelfarb (1992) shows how companies can achieve faster product development by setting up parallel marketing, R&D, manufacturing, engineering and finance teams. And, Bobrow (1997) highlighted a list of key factors for products including a understandable strategic direction, a communal culture associated products, a reasonable allocation guiding principle of resources and people, and a cross-functional team committed to the product development process.

Process development and product development are two dissimilar disciplines and play different role, although there is the potential to draw many parallels between the elements that support them (Lu and Botha, 2005). And, enterprises need constant product development activities to stay competitive in the market and as they shift into an era of continuous innovation (Angel, 1994). Since, their product development process ought to manage stakeholder's requirements – technical, financial, legal and environmental feature, customer requirements, corporate strategy and etc. Even though, process development involved definite technical and managerial challenges that remained unaddressed by existing literature and there is a little discussion how strong process development capabilities might conduct to better competitive results or might improve a company's product development performance.

There are lots of modelling methods in product development processes introduced by different authors like; Information flowcharting, information flowcharting (IFLOW) which is an icon-based modelling method, for describing a production system or a process and for distributing them for simple modelling templates (Wang, 1997). In IFLOW, the model shows 'who (a person or a group) does each activity 'and the time sequence in which these activities are performed'. Process flowchart (IBM, 1969) which is the classical process representation to show the activities in boxes and relationships are on arrow. Newt work diagram PERT chart or activity on node diagram (Moder et al. 1983), IDEF method (NIST, 1993; Marca and McGowan, 1993; Mayer et al. 1995), design structure matrix (Steward, 1981; Browning,2001) which is a structured network of activities with substantial and cyclical dependencies, petri-net modelling method (Tacconi and Lewis, 1997) which is an event system of activities, process programming method which includes rule-based method and systematic dynamic method (Zhong et al. 2005), extended event-driven process chain (eEPC) diagram (Scheer, 1999) which is an architecture of integrated information systems method and includes functions (i.e. activities), events, information items and products (i.e. deliverables) and organizational units and so on.

3.4 Decision Making Processes

Decision making is vital for the success of a business and enquire efficient execution and especially the organizations that have placed more attention on cost reduction and flexibility as a core competence, should consider the relevance of these activities to the organizations' performance (Ancarani and Capaldo 2005). Decisions must be in high quality and should be achieved through deliberation. So, the place of timely decision making is eminently important and can lead to competitive advantages in highly dynamic environments (Talaulicar, 2005).

The process of decision making in a group is very dynamic and at times complicated process with many influences and factors which depends on group of individuals. So, understanding how a team makes a decision is very important factor (Sasou et al. 1996) and coordination among such groups becomes more challenging as their number and interdependencies grow (Browning, 2009).

In addition, it should be considered that certainly no individual is able to grasp all of the important details, nor would such an individual have the required skill to do all the work. like in project environment planners, managers, various designers, builders, subcontractors, etc., has their own different perspectives and each party requires different pieces of information to perform their tasks. So, collaboration among decision making team is needed to help companies to adapt to uncertain and dynamic environment (Miller and Lee, 2001). It means that, the central dimension of decision making is collaboration – the degree to which people communicate and interact with each other in making decisions.

Due the demand, complex issues typically are enormous for any individual with different types of experiences to ensure the cognition of quality of decisions (Nahavandi and Aranda, 1994; Resnick, 1991). Many groups such as governing boards, cross-functional teams and task forces involve the participation of decision makers from diverse functional back grounds, multiple departments and organizational levels. Therefore, individuals often enter the group setting with different assumptions, viewpoints and interpretations of the issue involved. Although group members may have similar goals (i.e. reaching the best decision), their different thought worlds (Doughtery, 1992) interfere with the ability of the group to cognitively view issues in similar ways (Mohammed and Ringseis, 2001).

3. Literature Review

Moon et al. (2003) studied about the use of groups and teams in organizations that has grown significantly over the past several years (Cohen & Bailey, 1997). In fact, Parks and Cowlin (1995) noticed that most of the important decisions within organizations are made by groups or within a group context. Research in group decision making has discovered that compared to individuals, groups sometimes make better decisions (Libby et al. 1987; Sniezek & Henry, 1989).

According to Rosenau and Moran (1993), Bowen et al. (1994) and Bobrow (1997) a cross functional (or multifunctional) team could be a success factor in product development processes. So, a multifunctional team can be defined as a group that develops a common project and where members are from more than one functional area, generally from the areas of marketing, R&D, engineering and production and so on, that affects the performance, by increasing the quality and variety of available information (Lu and Botha 2005). Moreover, the involvement of all functional areas was not only to have people at the meeting who could tell everyone else how things work in their area, but also to create a feeling of ownership and justice for all involved (Davidson et al. 1999; Beugre, 1998).

Sasou et al. (1996) stated that, there are many merits in working in a team. Cooperation and communication will improve both productivity and make the working conditions safer. Along with individual factors, small group factors and organizational factors are also important in team decision making processes. Therefore, the entire process of decision making hinges on ability of group members to identify the weaknesses or faults in each other’s ideas.

Knowledge based analysis methodologies and tools have been developed by system engineers to support the decision making processes all over the product/ process/ system lifecycles. However, depending on the lifecycle phase in which each decision maker operates in different level of detail of the required and available information is needed (Colledani et al. 2008).

Ronchi (1980) determined the decision-making technology as a mechanism through which the information input is translated into decisions. This mechanism is essentially composed of conversion values “which include cause/ effect hypotheses and logical rules of inference and Process constrains affect the rationality of the decision-making process. The process of decision making in a group is very dynamic and at times complicated process with many influences and factors which depends on group of individuals. The potential of human related problems still exist and must not be neglected. To reduce the possibility of such problems, understanding how a team makes a decision is very important factor (Sasou et al. 1996).

In addition, the place of decision making is extremely essential as well. Only timely decisions can lead to competitive advantages in highly dynamic environments. It is essential for management scholars and committed managers to realize the factors that impact the efficiency of decision making processes. In fact, both comprehensiveness and rapidity of decision making are two significant aspects which to be analyzed in more detail (Talaulicar et al. 2005).

Marques et al. (2010) Decision making in a project context is a complex undertaking. Therefore, managers in front of complex project require to access to a decision making aid model based on applicable performance assessment. In this condition modelling plays an significant role in project management in supporting "complex" decisions. Modelling is often offered as a simplification of realism and this enables managers to analyse and come to conclusions (Wiliams, 2002). So, the key purpose of modelling is to help decision makers take a better decisions in a project context.

Sasou et al. (1996) processed a model to simulate the team's decision making process, named the disagreement resolution model in which simulation system for the behaviour of an operating group successfully replicate the decision making process of an operator team coping with abnormal occurrences or events during power plant operations. They also verified the accuracy of the model with experiments of live subjects and was confirmed that this model can simulate a team error under complicated circumstance or situations. Actual operators go through the process of first gathering information and making decisions individually. Each has knowledge and personal viewpoints depending on education, training and experiences. For this reason, conflict over proper course of actions may happen. Therefore, to side step disagreement, final decisions are generally made through communication and a course of actions is agreed upon by agreement. The final decision may be an alternative or a derivative of an initial idea or an entirely new one which arises during discussion. It has been shown that simulating various options within an operating team's decision making process is necessary.

3.5 Project Management Processes

Project management is a naturally complex problem. Very often, project plans and schedules can only be drawn up in presence of many different sources of internal (e.g. reduce the cost, increase productivity)/ external (e.g. improve the service or product provided, increase customer satisfaction) Papamichail and Robertson (2005) uncertainty, especially large projects where conflicts in schedules are common. Project managers often have to face to many unknowns in the project planning stage since design and approvals are highly people dependent and customer requirements often change in during projects. Therefore, managing a single project is not an easy task and multiple project managing is more difficult significantly (Chan and Chung, 2002).

Decision making in a project framework also is a complex responsibility. The complexity word is an more and more essential point of reference when we are trying to understand the managerial difficulty of modern projects in general, and of the various situations encountered in projects (Kahkonen, 2008). Complexity can appear in different forms and arise from various sources with different levels of concentration according to the industrial sector or objective of the project. Intensities can vary over time and this variation underlines the dynamic characteristic of project complexity (Marques et al. 2010).

To ensure that projects can be completed on time and within budget, a good project management tool is required. The earliest project management tools like; Gant chart (Gant, 1919), CPM and PERT (Elmaghraby, 1995), which originated independently in late 1950s, are mostly for scheduling activities. Although these tools remain popular, there have been enormous extensions to them. These include GERT, P-GERT, Q-GERT and others (Knotts et al. 1998; Moore and Taylor, 1977; Neumann, 1990). There are currently many project management tools (PMI, 2008) that facilitate project planning and estimation, as well as project tracking and control. However, many of them are standalone software that does not support a multi project environment which requires workgroup communication and coordination. Also, for many tools, the project status cannot be tracked and project managers have to maintain the progress and update status manually. For develop the projects to be successful, we need more innovative design of project management tools (Liu and Horowitz, 1989; Elmaghraby, 1995). This is especially the case with multi project environment. For such projects, there is a need for sharper processes to be defined, tracked and overseen. There is also a need for better project control and monitoring to ensure that any deviation from the original project plans be addressed immediately (Chan and Chung, 2002).

In fact, in order to address issues like; gaining competitive advantage, managing projects and meeting deadlines which are just few of the problems that managers has to face nowadays, new control mechanisms need to be developed (Papamichail and Robertson, 2005). And, some of the problems in project management could be understood by definition of project process interactions. As the project management profession is evolving, project managers could get a role to tell something more specific about migration from product-oriented thinking to processes-oriented thinking. In that case, a design of project process interactions can serve as a standard project process reengineering tool (Abdomerovic and Blakemore 2002).

According to Project Management Institute standard, a project has been defined as a temporary endeavour to create a unique product or service and project management is defined as the application of knowledge, skill, tools and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project. Or, a project is a temporary and transient organization surrounded by inherent uncertainty (Turner and Muller, 2003). In other word, a project is intrinsically unique and strongly subject to environment (Zwikael et al. 2005). And, any international organization for standardization could defines project as “a unique process” (Marques et al. 2010). So, Project management as an engineering discipline in structural design and production can be seen as a mature issue as it is well used and understood in these areas (Merwe, 2002)

Even though, projects and process are different, they can be integrated as they are related and share some characteristics in common. A process instance is an instance of specific type of process (e.g. engineering or manufacturing) and it can be optionally part of a project. By integrating projects and processes, therefore a project manager can chose to focus only on those process instance that are part of a project (Chan and Chung, 2002).

3. Literature Review

Abdomerovic and Blakemore (2002), Project includes processes that generate project product. And processes organize work necessities to create project result. These processes are known as product-oriented process and project management processes. There are several explanations why project process interactions should be defined, e.g. need to make understandable roles, responsibilities and reporting hierarchies or essential to understand project risk areas And so on. Project management could be seen as business processes dynamics that turns vision into project deliverables as well, which brings a team together from different levels of education, social backgrounds, mindsets and experience to form a coercive group that can achieve to common objectives in an efficient and effective manner (Merwe, 2002)

Moreover, the project management process could be designed to control a number of potential fail points, especially where there is a need for customer contribution or confirmation These weak points cover the whole project life cycle of initiation, definition, implementation and completion. Control is exercised by a formalization of a number of key activities, with a requirement to keep as documented procedure (Bryde, 1995)

As an example from recorded literature, (Willoughby, 2005) examined the nature of project expediting operation in the Oil and Gas industry. Expediting represent an approach for managing the materials used in a given project. Specifically, it monitors the performance of suppliers and subcontractors so that required products are manufactured to appropriate quality levels, within contractual deadline dates. He claimed that successful implementation of suggested expediting process – i.e. teamwork, break a project into specific and useful milestones, use concrete terms when setting up project contracts, use a project neutral, initiate a project pre-award meeting, implement strategic alliances, continuous appraisal of a project’s developments, fail to hire rogue vendors, contractor screening and create a coordinator of vendor development position – into the expediting process operations of Oil and Gas projects can lead to substantial benefits.

So, the project management should plan and control the project, establish and schedule activities, run commitments, etc. project managements is facilitated by a well thought-out approach, particularly one supported by models of what work can and should be done, when, and what information can and should be created when –i.e. processes models (Browning et al. 2006) and in order to cope with project challenges, project managers usually depend on process methods to map and organize project work. because a process consists of all activities and relations required to complete a project **.**Project managers may utilize one or more process models for a range of purposes.(Browning, 2010).

Verma et al. (2010) conceptualized the concept of project timeliness (i.e. delivring the right product at right time) in an organization where multiple projects are being executed in parallel and develop a process model of project flow to manage project timeliness. They established the significance of process model to evaluate the impact of the change in the project priority decisions and resource allocation strategies through its relevance at the high tech firms.

So, a project process (here in after, simply "process") is the set of associated activities that complete a project (or program). That is, all work done on a project is part of its process (whether formalized or not). Since these various work segments depend on each other, processes are often modelled as an activity network. Information about process may be organized and conveyed to different users (planners, managers, workers, etc.) through different models (Browning, 2009).

Next section will be summary of reviewed process models in the literature.

3.6 Process Modelling/ Process Models

The system of product development process management incorporate process modelling, process analysis, process improvement and process reengineering, process monitoring and conflict management according to (Zhong et al. 2005). Also, managers of large and complex projects need suitable application of model observations that filter and organize the relevant information with the purpose of making important decisions (Browning, 2010).

A model is a conceptual representation of reality that is built, verified, analysed, and influenced to increase accommodating of that reality (Browning et al. 2006) and efforts to represent the process's significant features. Process models are built for a function, for instance; to document the way work is done, to estimate the duration of a project, etc. The information captured in a process model may be organized and conveyed to users (i.e. planners, managers, workers, etc.) through different views. A view captures a division of a model's attributes and provides a principle for their presentation (Browning and Ramasesh, 2005). But it should be well thought-out that a process model which has been made for one function may not be functional for other purposes, although this type of misuse is common in industry (Browning, 2010).

Naturally, there is a discrepancy between the real system and a model of it. The size of this discrepancy is determined by the model's richness, consistency, accurateness, realism, etc. in modelling, confirmation and validation are used in an effort to close the gap. Nevertheless, many models can be fairly practical regardless of gaps, if these gaps are chosen correctly. A high-quality process model should pay extraordinary consideration to the interfaces amongst activities (Browning et al. 2006). And a valuable model is helpful for building predictions and testing hypotheses about the effects of reflected action in the real world, where such trials would be excessively disrupting or costly to try. Scientists usually focus on explanatory models which validation and estimation of modelling error are practically impossible while, engineers and managers prefer predictive models, (Hazelrigg, 1999).

Process models provide the input to sharing assumptions, consideration the areas of project hesitation and uncertainty, managing commitments and accountability and carrying out the project on timetable, within budget, to condition and with minimum surprises – every manager's goals, which can be descriptive, prescriptive, or have portion of both. A explanatory process model effort to capture understood knowledge about how work is really done. It tries to describe key features of the "as is "reality. On the other hand, a prescriptive process model tells people what work to do and possibly also how to do it. A prescriptive process is typical process or method along with an authorization to track it exactly. Prescriptive processes become more rhythmic. Before becoming prescriptive, a process model should accumulate an adequate amount of information, knowledge, and accurateness to make sure its likelihood and effectiveness (Browning et al. 2006).

Usually, process models provide a base for (frequently consequential from a work break down structure – WBS) and their dependencies; planners can catch an idea of project's critical paths, time, etc. then, they can discover opportunities to decrease project timeline (Browning et al. 2006).

The process ties to project in several ways. In other word, if the project were a sentence, the process would be the verb. for this reason, a useful process model is the foundation for an effective combination of the project system models and the efficient management of projects (Browning et al. 2006).

Processes can be considered and treated as systems which cleverly, assisted by functional models (Negele et al. 1997; Pajerek, 2000). A system is; A commonly interacting or mutually dependent group of items structuring or organizing a unified intention or a group of procedures or simulated substances or an association form of a network to share a common goal, or accomplishment of a defined objective(Browning et al. 2006).

The process system is the effort completed and provisional outcome achieved to generate the product system, which consists of associated activities. The organization system consist of people allocated to do the job to make the product system – i.e. individuals, groups, teams or other organizational units, related to each other by communication, reporting, and etc. the tool system stand for the technologies used by the people to do the job to get the result. Models of the product, process and organization systems normally exist to some extent in most projects, these models are infrequently incorporated or used to validate each other in industry. This is a misfortune, since a remarkable amount of waste could be eliminated, and much more knowledgeable practical and managerial decisions could be made, if integrated models span these systems (Negele, 1998; Negele and Wenzel, 2000).

A process is system, and, because of its vital relationships to the other systems in a project, a model of the process system is an excellent basis for integrating models of the other project system. A generalized framework for process modelling could provide a basis for integrating the different models in use across and organization. With an integrated process models – one that accounted for activity durations, costs, relationships, effects on technical performance criteria, effects on risk measures, pitfalls (failure modes) and lessons learned, etc. – an organization would benefit by being able to explore “what if” scenarios that traded off cost, schedule technical performance and risk(Browning et al. 2006).

In the modelling of the product development process, different people such as managers, developers and engineers may have different requirements for the process. It is necessary to describe the process in different aspects and form different views for the process. So the ideal method is to build and integrated model base on multi-view for product development process. In the model users can describe and use different parts of the process and different stages of process, they can model the different parts of process and describe the activities and roles and resources, they can also analyse and optimize the process model and even can improve and reengineer the model (Zhong et al. 2005).

Process models can be built for a variety of users beyond project scheduling and compliance with external standards. Drawing from lists by Fricke et al. (1998) and Browning (2002), tableI provides a list of potential purposes for modelling processes. Browning and Ramasesh (2005) provide the arrangement of purposes shown in table II. Models built for one of these purposes are often not very useful for the others – not that this need be the case; it just often is. Different users have different needs and require different information, emphasis and views. So, the variety of users and needs for process models is part of the reason why there are so many modelling frameworks in academia and so many disparate models in industrial organizations (Browning et al. 2006). So, according to different requirements and applied backgrounds, researchers proposed various kinds of process methods and technologies.

- To focus on value –adding activities, not on figuring out where to get inputs and where to provide outputs.
- To provide transparency and situation visibility to workforce, so each worker is empowered to see their part in the whole enterprise.
- To ensure good decision-making by the right people at the right time using the right information.
- To meet commitments in predictable, repeatable, consistent way.
- To support understanding of and learning about complex processes.
- To benefit from captured best knowledge on how to do certain things.
- To provide a “scaffolding” or skeleton for organizing knowledge about work and interactions (knowledge management).
- To plan and mange work with some accuracy and confidence.
- To help avoid failure modes that best previous, similar processes.
- To have a common vocabulary to discuss the work and its results.
- To codify an approach to accomplishing a project, against which each participant can compare their own mental model and either alter it to align with the group or trigger a discussion about potential problems.
- To provide a baseline way of doing something, against which improvements can be measured.
- To use a common, best approach when people do similar things on different projects or programs.
- To enable “what if” analysis of potential process changes.
- To enable innovation process improvements (reengineering, lean, etc.)
- To convince customers that a reasoned, proven approach is being used to meet their needs.
- To convince auditors that work is done to certain standards (e.g. ISO9001)

TableI- Some uses of Process Model (adapted from Browning et al. 2006)

Product Development visualization a. Actions, interactions and commitments. b. Customized. 2- Product Development Project Planning a. Making commitments b. Choosing activities. c. Structuring the process. d. Estimating, optimizing and improving key variables (time, cost, etc.) e. Allocating resources. 3- Product development execution and control a. Monitoring commitments. b. Assessing progress. c. Re-directing. d. Re-planning. 4- Product development a. Continuous improvement b. Organizational learning and knowledge management. c. Training. d. Metrics. e. Compliance.

Table II – Taxonomy of Purpose models (adapted from Browning and Ramasesh, 2005)

One of the first process models of industrial product development was proposed by Cooper (1983). Cooper's seven stages model serves as a nominative guide to managers to ensure that many of the critical steps in the product development process are not overlooked. One of the limitations of cooper's model in the current business environment is its unit of analysis, which is an individual project.

Maio et al. (1994) interpretative modelling framework also accounts for projects interdependencies that explain a firm's dynamic behaviour in managing product development projects. The framework utilize two generative mechanisms; expected profitability and projects' risk for decision related to individual projects' evaluation, classification and priority assignment.

3. Literature Review

Adler et al. (1995) proposed an empirical modelling framework to overcome some of the limitations' of Cooper's process model. Their approach focuses both on the management of resources and on the management of individual projects. Their empirical framework for analysing of product development times suggests a significant difference in development cycle times between high priority and low priority projects. In the process model of product development proposed by Adler et al. (1995) the priority of project determines how resources are allocated to the project. While high priority project is likely to receive all the necessary resources at the desired times, a low priority project is likely to experience longer waiting times before receiving the necessary resources.

Petersen et al. (2005) proposed the early supplier integration (ESI) model as a product development process, since managers can develop and manage the business relationship with suppliers and it has meaningful financial benefits, and (Mohammed and Ringseis, 2001) presented a method for knowledge based multi-view process (i.e. PDPM which is one of the key enabled technologies for the implementation of CE). The PDPM system is developed to coordinate activities in concurrent product development process, control and validate the product development process. Naquin and Holton (2003) developed a competency model which involves a multi-step process. And (Chan and Chung, 2002) developed an integrated project and process management tools called IPPM (integrated Project and process management) which exploits the maturing collaborative technologies to facilitate multi-site work group communication and coordination on variety of hardware and software platforms, such features reduce project costs and save time. IPPM also has characteristics of a process-centred software engineering environment (PCE) (Grag and Jazayeri 1996; Thayer 1997). IPPM integrates process and project management and has a number of useful features to facilitate the streamlining of software development process. It allows team members to synchronize their work, share information and to communicate with each other, irrespective of their physical locations. It supports the dynamic handling of tasks, which allows project managers to more easily cope with a changing a business and software development environment. Is has also useful features to support quality management and process improvement.

3. Literature Review

Colledani et al. (2008) presented a conceptual framework for the knowledge-based integrated description of product-processes and production systems. The proposed conceptual model meets the requirements of flexibility (i.e. easily adaptable to different production context), scalability & extendibility (i.e. in terms of level of details), and integration (product, processes and system are all considered) according to user needs.

Papamichail and Robertson (2005) described two process models (i.e. D2P and P2E) that reflect the two approaches (i.e. decision making and regulating). Any time, there is a difference between reality and untended, a process model can be selected to eliminate or minimise the difference. The choice of a model depends on several factors such as level of management, complexity of the problem, familiarity with the problem, range of potential solution and urgency of applying corrective actions. It is believed possible to accommodate the D2P and P2E models in a generic management control process model. The P2E and D2P model are implementable and themselves evolvable, supporting the coordination between actors in the management process.

Hughes and Chafin (1996) presented the Value Proposition Process (VPP) that was developed by the sponsoring company to transform its existing product stage-gate process. Implementation of the process should be positioned as part of concurrent engineering a system to capture corporate memory and a culture that accepts change. Members of value chain, such as suppliers, manufacturers, channels of distributions, shareholders and employees, may measure value added in economic terms such as increased margins, faster inventory, turnover, growth rates, market share, higher returns on investments, economic value added and higher incomes. The VPP designed to improve the efficiency and effectiveness of multifunctional project teams through continuous learning, identifying the certainty of knowledge, building consensus and focusing on adding value to customers and end users. The objective of the VPP is to determine if the organization can convert an idea or an opportunity into a proposition that adds value to the end users, the company and the value chain. In short, the team must answer a basic question, can we do it right? The VPP consists of a framework of continuous planning cycles, called the value proposition cycle (VPC) and an integrated screening methodology, called the value proposition readiness assessment (VPRA).

3. Literature Review

Product development process is usually broken into sequential stages (or phases), so that requirements can be checked against plans to evaluate the process alignment and trends towards the objectives. Checkpoints between phases involve Go/ No go decisions, leading the process towards later management decisions or terminating projects that do not offer good chances or revenue/ profit to the company, nor opportunities for a better strategic positioning(Rocha and Delamaro, 2006).

Based on the budget and phases information, it would be possible to create a decision making tree, with all key decision-points along the whole product development process. And recommended to the organizations that develop the product should have structured product development process which contains stages/ phases for all project and product life cycle. Hughes and Chafin (1996) discussed about stage - gate and phase - review concepts as below;

Phase – review process; the phase review process lays out the product development life cycle into sequential steps. Each phase and step has defined inputs and outputs. Management reviews the outcomes at the need of each phase and makes Go-No Go decision.

Stage-gate process; requires completion of stages before the project can pass through a gate to the next phase of development, but it differs from the phase – review process in that use it uses functional teams that operate in parallel to reduce the critical path and to better coordinate the later stages with the earlier ones. This process encourages cross functional teaming and emphasizes the needs for a market orientation, but its implementation is made difficult by the dynamics of time, changing organizational structures and the transfer of key personnel (Connor, 1994). It provides project teams with a flexible capability for asking the right questions, identifying the major gaps in knowledge and managing the top priority uncertainties much earlier in the development cycle. The stage-gate process has been credited with speeding products to markets in a variety of industries (Cooper, 1993).

Prasad et al. (1998) studied about workflow process model which is a composite (representing product, workflow, organization and resource in one model) concept and INFLOW is a useful method for capturing workflow management (WM) process. Since one or more factors influence the WM, the analytic hierarchy process (AHP) method is studied to evaluate the process's performance (i.e. X-abilities) and to measure the benefit of an improved process. Workflow management (WM) is an analysis or study of the business process in an enterprise or company so as to optimize the flow of 'product', 'work', 'organization' and 'resource'. The 'optimizing workflow' means determining an effective distribution of the aforementioned elements. And the work process model employs a parallel distribution of task in addition to deploying parallel workgroups. In this way, while a workgroup is working on a task, another workgroup can be working on another task, belonging to the same track. If the work tasks require collaboration, these two workgroups can work concurrently and will be able to collaborate as a team for that stage of product development.

It seems to exist in millions of various, fashions and styles of process models and methods of modelling in project management and product development filed as some of the relevant ones to product development and project management process developments has been presented in previous sections (i.e. product development processes and project management processes) which we cannot address all process modelling frameworks and methods. Many of the existing process model frameworks have been developed for a specific modelling purpose that come from software and engineering back ground and were not designed for business modelling in the first place (Recker, 2006).

3.7 Why Process should be validated?

Lu and Botha (2005) Process execution occurs simultaneously with process design during pilot runs and then becomes the dominant activity in a mature organization. Prototyping is an experimentation technique that has received much literary attention and has been described as important for the speed of development and quality of design (Hargadon and Eisenhardt, 2000).

Papadimitriou and Pellegrin (2007) defined **i**ntermediary Objects of Design (IODs) which include all objects such as design, prototypes, descriptive documents and pilot implementations produced by the project team and enclosing an intermediary representation of the final deliverable in some tangible form. Pilot applications are technical IODs on the border between project and permanent implementation. Pilot applications are also the ultimate open objects of a project, because they open the final deliverable to more or less modification through an ultimate test.

Bare and Cox (2008) also said that, If we start with a poor, inaccurate or invalid model of a product optimization, no matter how effectively applied, will result in poor solutions" (Otto and Wood 2001). Engineering companies compensate for this deficiency by testing prototypes to obtain empirical data that can be used in place of predictive models. Toyota claims that through the use of many simple prototypes, it can be develop cars with fewer people and less time than companies that rely heavily on computers. Built it, test it and fix the things that go wrong. Repeat the process until the desired reliability is achieved" (Doebelin, 1995)

3.8 There is no best process model

A wide range of literature exists on success drivers in product development projects. This literature has identified a number of best practices success drivers indicating how to conduct projects. The success factors vary somewhat according to industry and on the newness of market and technology. Loch (2000) examined the effect of best practices principles in product development projects based sample on 90 projects in a large, diversified, European based, multinational technology manufacturers. Based on empirical findings, he has arrived at the conclusion that there is no best practice for product development. Rather, a company should develop a customized product development project portfolio and corresponding mixture of processes, which together meet its strategic innovation needs. Since, fact there is no any acceptable evaluating standard to evaluate a method of product development process modelling and management (Zhong et al. 2005).

In fact, a process model includes the attributes of and the underlying assumptions about a process which are deemed sufficient to describe it for a particular purpose. What determine a "Good" or useful process model depends on the users and the decision to be supported, and thus a model fit for one use may not be appropriate for another (Browning et al. 2006; Crowston, 2003). Thus the fitness of a process model depends on the alignment its content and structure with what is appropriate to support a particular decision, purpose or use case (Browning, 2009)

Summing up all the reviewed literature regarding the product development processes, decision making processes and project management processes shows us, in order to remain competitive in the current market situation process development is mandatory for project organization specially, the ones who deliver product/ service including design/ engineering, production functions. So, as Patnayakuni and Rupple (2010) recommended, with application of a socio-technical approach to design a structural approach for assessing and redesigning work systems is based on principles (Cherns, 1987; Mumford, 1995), which can provide an integrated guidelines for entire organization. The principles with brief description are; error should be detected and corrected, decision making should be explicit and the decision making process should be designed and structured to maximize information availability and knowledge utilization, introducing variety in the work organization through multi-functional teams and multi skilled individuals, Compatibility of design process – the process of design of the technical and social system should be compatible to the needs of multiple users. So, an integrated process model with application of process modelling method which fit to organization requirement could be a proper solution to develop the entire organization.

4. Methodology

In the dynamic business environment of today, maximizing and optimizing business performance is a critical requirement for maximizing business profitability and, companies are forced to take the advantage of any opportunity to optimize their business processes (Sanayei et al. 2010). Therefore, it is critical to study methodologies of product development, establishing connection between concepts of decision making processes with better practices and models to help management to maximize the expected value of the investments in product development which means a radical look at what makes them successful.

The current chapter would be a description of methodology of the Smart Execution Process Development research as a qualitative and analytical research. After initiation and definition of SE process development research by PSN unit at ABB UAE Company, the researcher collected and reviewed over three hundred of articles and number of books to get the relevant information about the concept of what is a process, what is a product development process, decision making processes and why and how a process should be developed, redesigned, reengineered or optimized, why a developed project should be validated and how, what is a process model and what have been done regarding the developing an integrated process model by previous researchers and so on.

After first review of articles, almost half of them eliminated and note taking started. After completion of notes, the collected notes have been edited and divided to different groups relevant to above listed concepts. After second and third edit about the concepts and the separation of sections the Introduction and Literature review chapters articulated.

In parallel, the smart execution process development project (i.e. current research and development project) started at ABB UAE Company. There are over 250 employees in Power System Network (PSN) division of ABB UAE Company which are running number of High Voltage Substation Automation projects, with involvement of different functional units at PSN business unit like; Bids and Marketing – which attend in high voltage substation and automation tenders, design/ engineering – which are responsible for design/ engineering of the projects, project management team to take care of project management function, supply chain team to take care of procurement of required items from suppliers and shipments of project deliverables, production team to assemble the equipments in the panels, wirings and taking care of factory acceptance test, test & commissioning team to test and energisation of entire substation and hand over the project to customer, project controlling team, project planners and etc. SE project team members have been selected from above mentioned functional units as well.

At first step the smart execution project team (i.e. SE team) has been identified in ABB PSN business unit to run the smart execution process development project at PSN Division of ABB UAE. Project manager (PM) who is the researcher, Design Engineer (DE), supply chain officer (SCM), production/ manufacturing manager (MM), test & commissioning manager (T&CM), project controller (PC) and operation manager (OP) were the SE team members who were belong to different functional groups like; project management, engineering, production, supply chain management and controlling functions. Roles and responsibilities and each person have been defined and the researcher (i.e. PM in SE team) was responsible to analysis of existing processes and develops the integrated model according to reviewed literature and redesigns the processes. In each step (i.e. the result of analysis and proposed processes have been reviewed and confirmed in SE team meetings to move forward to next step).

Initial brain storming meeting which was a two hours session, held by researcher, with SE team members and business unit higher management attendance to get some ideas about the current problems and undesirable effects on business unit productivity and profit. It was also important to identify the gap between what was happening in current situation and where the business unit wanted to continue in future (i.e. setting targets for the research project) and how they could achieve (i.e. methodology). The estimated development project (i.e. current research) duration defined about 6-8 months to achieve to project goals and SE team meetings continued on by weekly basis during that time.

Based on higher management recommendation the gate model has been applied for current research and development project (i.e. SE project). So, a gate is a business decision based on; Benefits, Status, Resources, Technology and Risk of project progress. And, the possible outcome would be to continue the project with or without changes or terminate the project as shown in Fig.1

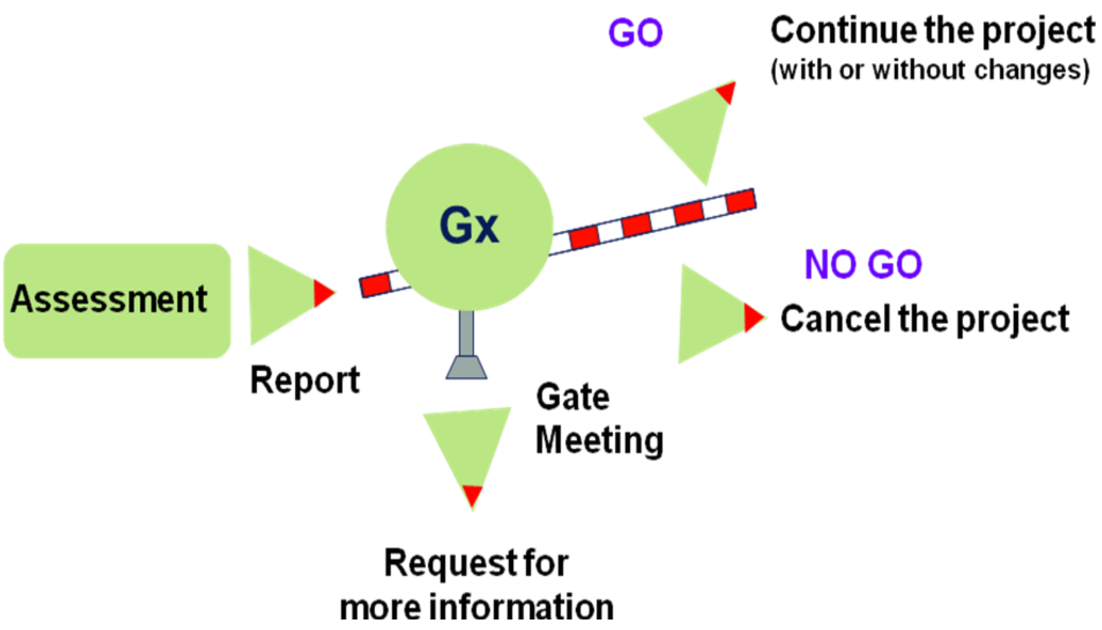


Fig.1 – Gate process

According to Fig.1, a gate is a decision point to determine whether to continue or terminate a project based on its benefit, status, risk, resource and technology considerations. And a milestone is a project manager's progress check point which shows how far a project has progressed against the defined criteria. A milestone enables project management to take corrective actions.

Roles and responsibilities in applied gate models identified as:

Gate Owner - the Gate Owner is responsible for controlling the project from a business perspective including starting, stopping and changing the goals of the project. The person should be the person who has the most benefit from the project management results (i.e. Business unit manager). He followed the project progress, made evaluation, gave support, advises and motivation to the team and appoint the gate assessor.

Gate Assessor - the Gate Assessor (PSN business unit operation manager) ensured that all of the information needed for decision making was available and evaluated one week before gate meetings with gate owner and project leader.

Gate Meeting Participants - Gate Meeting Participants helped to assess the project performance during gate meetings.

Project Leader - The project leader (i.e. the researcher) was responsible for the overall implementation of the project, analysis and development of management processes and recording the gate meetings.

Project leader (i.e. the researcher) assured that each gate meeting was held with Introduction (Agenda, Project Goals, and Actions), Gate assessment presentation, Discussion, Gate decision and listing the actions. And after each gate meeting, Minutes of meeting circulated among the attendees and the result communicated to all team members, document results kept in document controlling system and finally monitored the actions.

Why 4Q methodology has been selected?

The result of brain storming session was identification of problematic status at PSN business and requirement for research and development project to highlight the bottleneck problem. Undesirable business unit profit, level of customer satisfaction and reduction of market share were major triggers. According to financial figures, PSN business unit at ABB UAE was producing the same product as other ABBs (i.e. same business unit in other countries or regions like; ABB Saudi Arabia, India or Check Republic) with higher total cost and longer delivery time. In other word, the finished good is the same with same sort of control and protection devices (i.e. raw materials) with similar protection philosophies (i.e. similar design), but the total cost was higher and delivery time of product was so longer than the others. So, it could be the root cause of losing market shares in compare to ABB sister companies. The similar cause was valid for External competitors.

In general, there are four philosophies for understanding of any existing process behavior as shown in Fig.2 and the responses or actions could be;

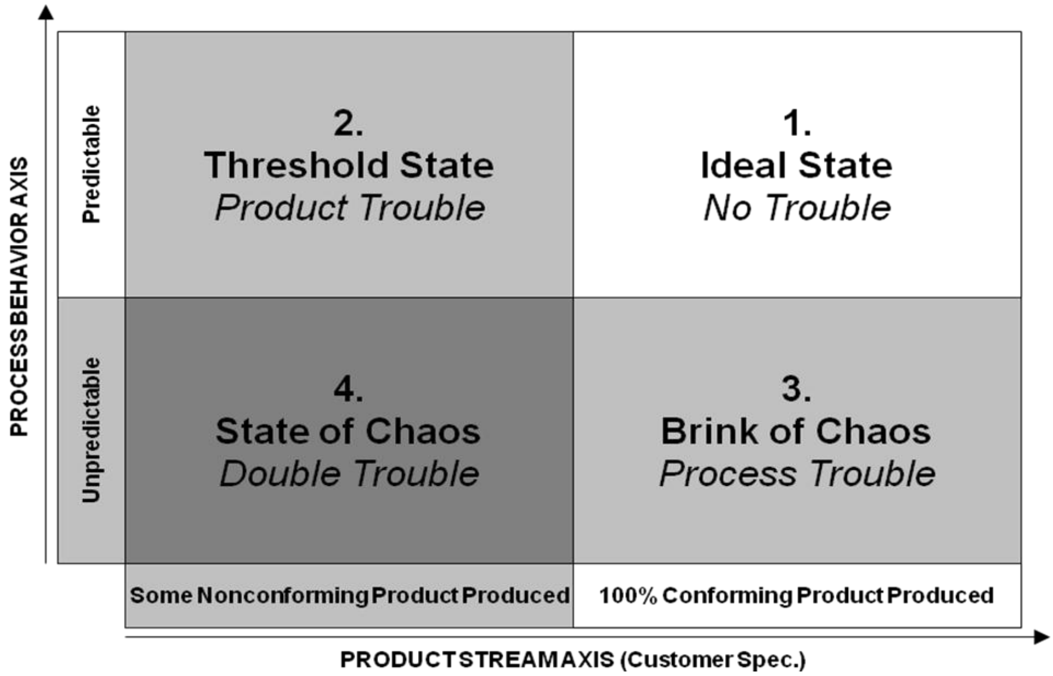


Fig.2

1- No urgent need for improvement in ideal state while, the existing process is predictable enough and the delivered product is 100% meeting customer requirements.

2- Sales team should have a discussion with engineering & production team about the possibility of changing of product specification in threshold state since the existing process is predictable enough but the product is not matching the customer requirement.

3- Use the 4Q methodology to improve the process in brink of chaos situation since the product is good enough to meet the customer requirement while process is not predictable enough.

4- Use 4Q to solve the special cause problems of process first, and then use six-sigma if it is required for fixing the product problem in state of trouble condition, since neither product is not matching the customer requirements nor process is not predictable enough.

The result was identification of “Brink of Chaos” status at PSN business and researcher highlighted the bottleneck in existing processes.

According to above mentioned philosophy, 4Q processes have been used by SE team and the researcher as a process improvement methodology as shown in

Fig.3. It includes 4 quadrants; Q1 – Measure (i.e. define the opportunity and investigate to understand the current state in detail which take some time), Q2 – Analyze (i.e. identify and confirm the root causes of the problem), Q3 – Improve (i.e. develop, pilot and implement solutions that eliminate the root causes) and Q4 – Sustain (maintain the improvement by standardizing the work methods or processes which is very important step in terms of efficiency and quality improvement of entire organization), and could cause fast and flawless executions but Q4 is not included in current research. In fact the current research will cover Q1, Q2 and Q3 only.

Moreover, ABB have improved the operational excellence in different business units in different regions and verity of divisions (i.e. OPEX) during the last 20 years by applying 4Q continuous improvement methodology, which is a problem solving method similar to six sigma's DMAIC (i.e. Define, Measure, Analyze, Improve and Control). 4Q provides a framework for teams to follow when attempting to solve a problem or improve a process because, if any organization tries to make improvements or solve problems without a methodology that seeks out to eliminate the root cause of the problem, the improvement will not be sustained and the problems will return.

In each quadrant, a set of tools identified and used which help to achieve the goal of the step. The advantage of 4Q was; provided a simple template for communication of summary information on improvement projects. And it helped in focusing on permanent improvement on the operational excellence through some basic sequence of events, not just an immediate fix or containment. Since, there is no magic pill to solve the problem at all.

The current qualitative research defined to facilitate the implementation of new set of management processes in entire PSN business unit at ABB UAE. So, the researcher also followed 4Q methodology partially for the current research (i.e. Q1, Q2 and Q3). Since the Q4 (i.e. sustain) was related implementation phase.

4Q Process	
Q1 - Measure	**Q2 - Analyze**
Define opportunity. Investigate to understand the current state in detail.	Identify and confirm root causes of the problem.
Q4 - Sustain	**Q3 - Improve**
Maintain the improvements by standardizing the work methods or processes.	Develop, pilot, and implement solutions that eliminate root causes.

Fig.3

Q1 - the purpose of Measure step was to narrow the improvement actions by defining the scope and learning about the existing situation which created an understanding about the customer requirements after identification of measures by the researcher and setting the time frame for SE project by SE team. Then, investigation of the existing processes in order to look for special causes. And, the expected result was the data which showed the bottleneck problems' location in existing processes.

The researcher used some simple tools like; check sheets – which systematically were records and data from organizational history or observations of results of past projects and it helped to find the patterns and trends easily, bar charts – which provided a clear display of data for decisions to be made quickly and easily and histograms – which were summary of collected data graphically.

As mentioned above, the researcher collected the past projects historical data and existing processes and analyzed them based on reviewed literature. Since each process was belong to separate functional unit, a separate review meeting happened with that functional unit representative (i.e. Concerned SE team member) to go through the process in order to check and confirm the identified weak points which have been done by researcher.

Q2 – the purpose of Analyze step was to identify the root causes of the problems or greatest opportunity for improvements, which organized and evaluated causes with their impact. The researcher have done the analysis by application of some simple tools like; cause & effect (i.e. fish-bone diagram) – which identified, explored and graphically displayed all the possible causes related to the problem, 5 Why's – which identified the real root causes of the problem by pushing thinking about potential roots causes to the root level and lean and 7 wastes – which helped to identify and reduce or eliminate the causes of the wastes (e.g. wastes of time).

Q3 – the purpose of this step was development and piloting the solutions. This step generated opportunity to evaluate the solution in pilot project. Through piloting the researcher could evaluate if the results (i.e. integrated and developed process) were good enough to move forward to next quadrant (which was implementation in entire organization) and make the changes permanent, or go back to Q2 to dig deeper and make changes in processes.

The researcher worked on SE process development research project with 4Q methodology and in order to move to next step the research results reviewed and confirmed in SE team gate meetings. As already mentioned, the current research covers till end Q3 which means making ready a set of developed processes for next step which would be implementation in entire business unit.

In order to have a good start for 4Q processes, some "pre 4Q work" activities should have been done by researcher as well. Like; review of customer compliance resolution process (i.e. CCRP) reports in order to recognize the "voice of the customer – (i.e. VOC)" or "voice of the business – (i.e. VOB)" as a trigger. In other word, "what is Critical to customer (i.e. CTC)" and "Critical to Quality – (i.e. CTQ)" should have been identified by researcher as key performance indicators (i.e. KPI). In order to show the connection between customer requirements and quality criteria, the researcher identified on time deliveries (i.e. OTD) as the most important KPI in ABBUAE - PSN projects, which is very important for customer and measurable.

So, the researcher in pre 4Q step collected some measurable and presentable data relevant to previous projects like; project based recorded/ consumed times by factory team, design team, project team and etc. and project review reports and PSN business unit financial reports as reliable data to provide the BU assessment report.

So, SE team identified 6 gates as shown in Fig.4 in project timeline. But as mentioned earlier, the current research could cover till gate 5.

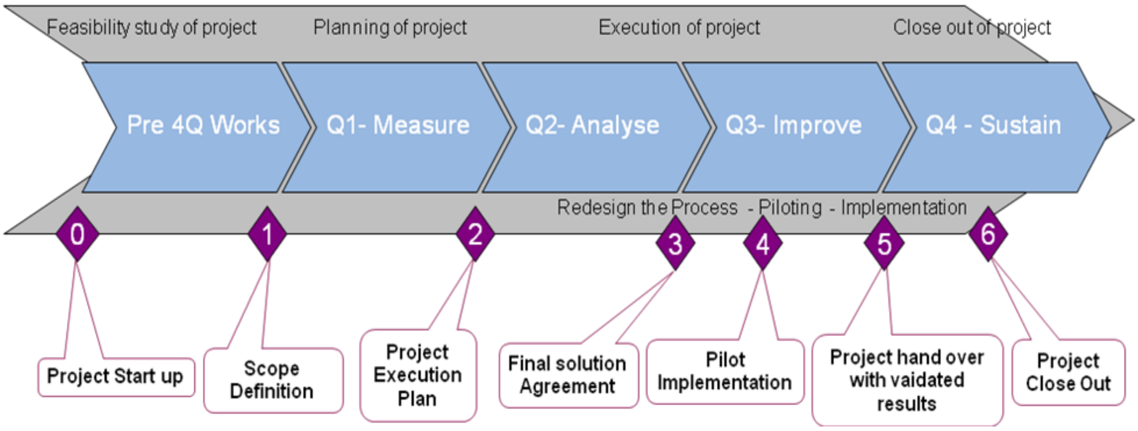


Fig.4

Gate0 was project start up and started with project Kick-off meeting and agreement on resources. The objective was evaluating an identify opportunities to start the project, according to presented check list in Fig.5. The SE team filled the check list in the project kick off meeting on December, 2009 after brain storming session.

Gate 0 Checklist *Status:*

	Project set-up and targets presented	
	Basic project timeline created	
	Project resources appointed	
	Basic project timeline created	
	Ongoing activities listed	

Fig.5

The next step was to start planning as a typical project, but SE team should have passed the G1 which was defined project scope according to shown checklist in Fig.6 in the first gate review meeting on January, 2010. The check list filled and signed and recorded as an attachment to Minutes of meeting.

Gate 1 Checklist *Status:*

1	Project Scope and Work Packages defined	
2	Project KPIs documented and monitoring started	
3	Assessment report completed (1st draft)	

Fig.6

As already mentioned, the purpose of Q1 was to understand the behavior of existing process and the researcher could not jump to Q2 – Analyze or Q3 – Improve before having a good understanding of the historical outcome of existing processes. In fact, Q1 would concentrate on the output of existing processes which is important for customer as KPI and should have been measured. So, the researcher in Q1 collected accurate and historical data relevant to previous projects to measure which were the basic data to prepare the assessment and review reports.

So, in order to pass the G2 gate SE team should have been agreed about the project plan and finalized the KPI which have been identified by the researcher.

G3 meeting was related to review and analyze the existing processes like; project management processes, engineering & design processes, panel manufacturing processes, supply chain management processes and test & commissioning processes collected and analyzed in detail by the researcher. Since in the G3 gate review meeting as one the important parts of the project, the weak points of existing processes should have been identified and presented and the final solution should have been explored.

In Q3 step new set of processes generated according to identified weak points of existing process along with an integrated process model which have been called "smart execution process model" by the researcher. The model included all the revised processes with including decision making gates which could show a bigger picture of project life cycle in PSN business unit in operational level. Any functional unit could implement the specified processes with gates internally and at the same time project manager and project team could find out which is the next gate/ step and could have been prepared for coming work load.

4. Methodology

In order to validate the process model, one project (i.e. Khalifa Ports Project including all control and protection panels and substation automation units for three 33/11kV substations) has been nominated as a pilot project and SE team was involved in all process gate meetings in project execution life cycle. As we mentioned earlier the researcher was the PM for pilot project. The scope of work for project included design, purchasing, manufacturing, delivery, test & commissioning of all control and protection panels and substation automation controlling units at three substations in Abu Dhabi Khalifa port area.

In G4 gate review meeting, the results of Khalifa port project has been compared with collected data from existing projects by researcher and the improvements has been shown to higher management. The result of G4 gate review meeting would conduct to G5 gate for handing over the new set of processes along with integrated SE process in order to implement of in entire business unit and application of them in execution of all new coming projects.

5. Analysis

In order to understand the existing challenges of PSN business unit, identify the improvement opportunities in the business unit like; order delivery cycle process (Sales, Project management, Engineering, Purchase, Production, Quality and related Office processes) and understand the customer expectations (i.e. better project lead time) and future business opportunities interviews with people in different functional people had been done and some project historical data collected which will be presented by author.

As already mentioned, the 4Q methodology has been used for Smart Execution Process research and development project according to shown gates in Fig.1.

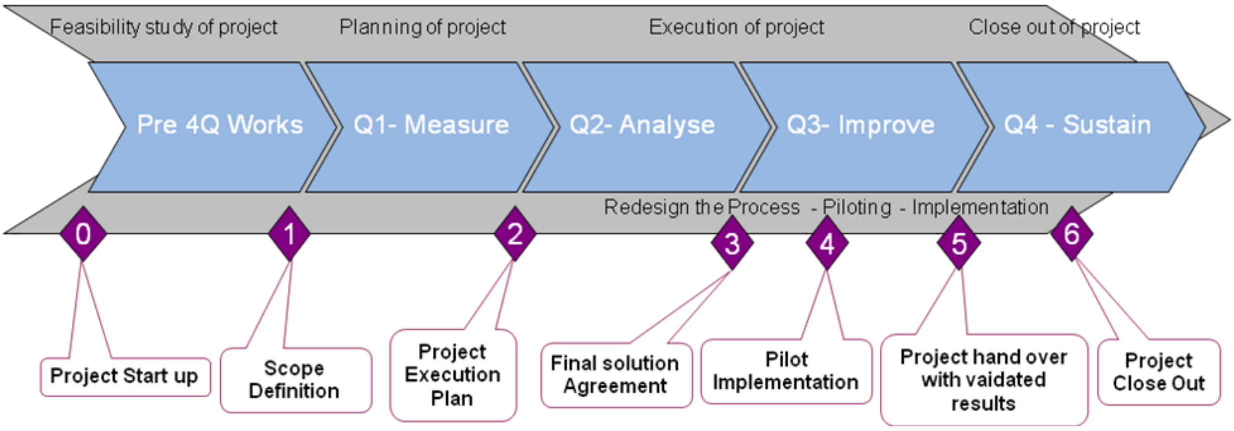


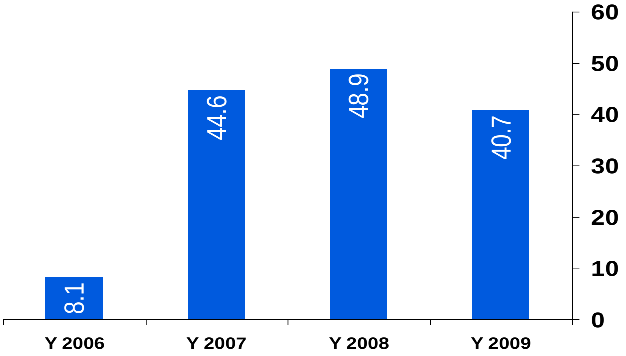
Fig.1

5. Analysis

5.1 Pre4Q Works:

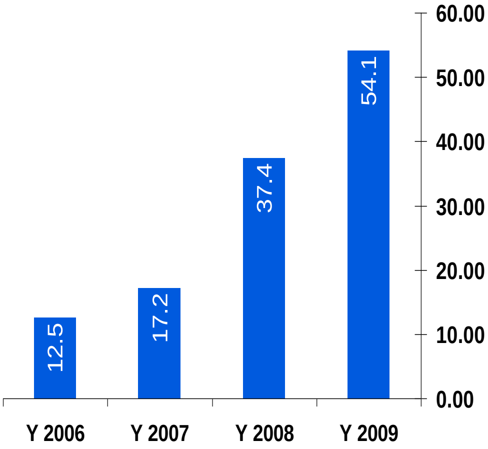
The first step in research was problem statement which was analyzing the business environment in last few years from PSN point of view to determine the requirement of research (i.e. Smart Execution Research and development project). The author submitted an assessment report to PSN management in January, 2010 which included the evaluation of PSN existing situation in the local business environment in following areas; the amount of received orders and revenues from 2006 till 2009, PSN Market share in UAE in comparison with ABB main competitors in similar business units (i.e. Areava and Siemens and so on), PSN business KPIs and some other key observations based on projects historical data.

a) The amount of received orders has been shown in Fig.2.

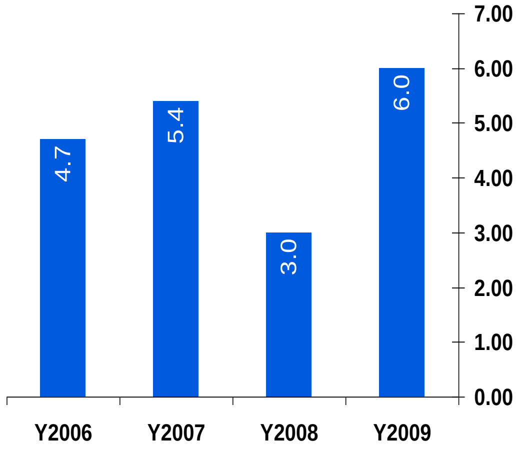


Order Received in MUSD - Fig.2

Based on received orders the revenue of business unit has been shown in Fig.3 and EBIT% (i.e. earning before interest and taxes) has been presented in Fig.4.

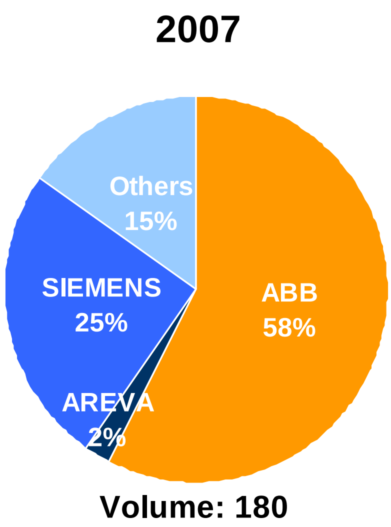


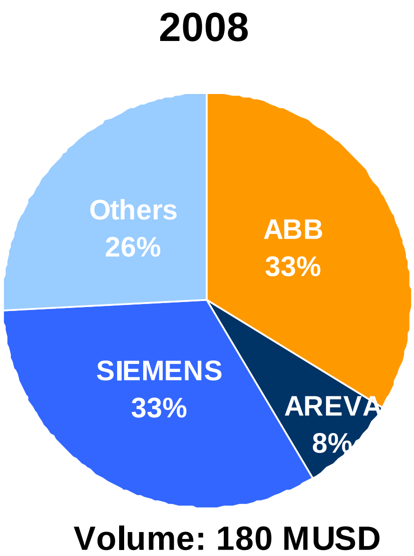
Revenue - Fig.3

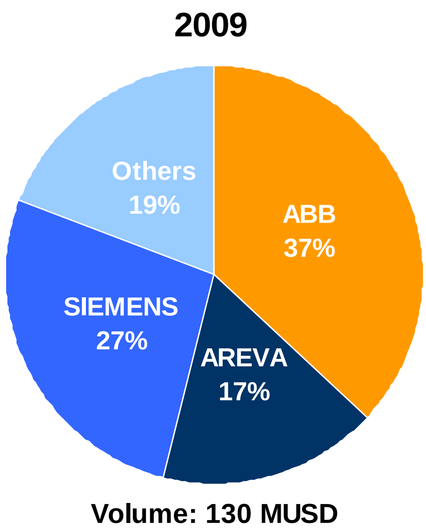


EBIT% - Fig.4

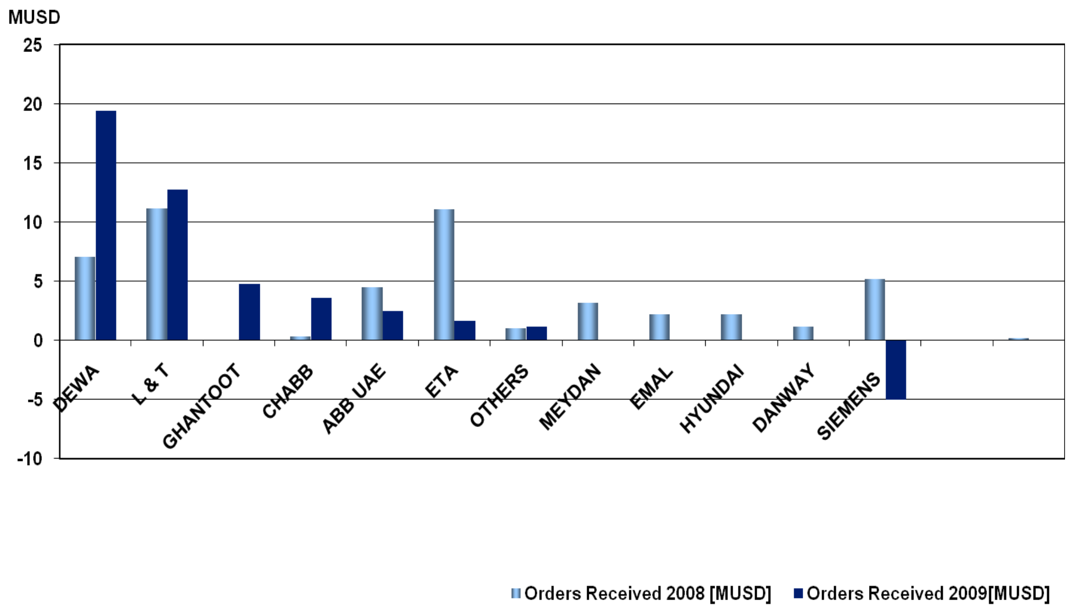
b) PSN market share in 2007, 2008 and 2009 which has been shown in below charts in compare with above mentioned competitors' presented that the PSN market share has been reduced in compare to 2007.







In more focused view chart 4 presents the PSN situation regarding the top 10 customers in UAE which are Dubai Electricity and Water Authority, Larsen & Toubro Limited, ABB Switzerland, ABB UAE – Power System Substations, Emirates Trading Associated, EMAL, Hyundai and etc. in 2008 and 2009 years in terms of received orders.



10 Top Customers Orders - Chart.4

And with consideration of <2MUSD as large projects in PSN business unit, as shown in Chart 5, the number of large projects in 2008 and 2009 was the same (which is 8), but the number is smaller project has been reduced from 18 in 2008 to 12 in 2009.

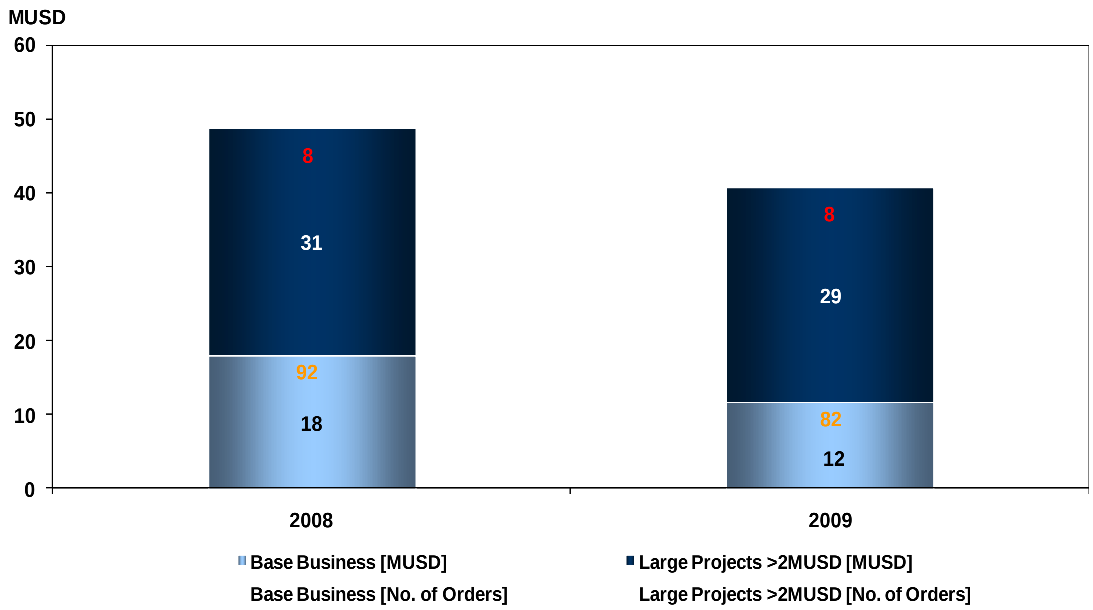


Chart.5

c) The considerable amount of cost of poor quality (COPQ) in project cost sheets, which was related to quality of delivered work to customer due to;

the amount reworks in design, the amount of reworks at project sites and the long list of FAT comments.

d) The review of project cost reports also highlighted that “As Sold” amount is always less than Project “Actual Cost”. It means most of the projects have Cost Overrun problem as well.

e) ABB Customer compliance resolution process (CCRP) reports – which is a quality survey tool to measure the customer satisfaction level globally and regionally, was showing that their interest to work with PSN has became down since the “ABB product is too expensive in compare to others in the market and the delivery time is too long” or “ABB response time is longer than other supplier in UAE market” or “ABB PSN quoted price is about 5% to 10% higher than other suppliers in UAE market”.

f) In compare to other PSN business units inside ABB (i.e. ABB same business units in other regions), the total cost of finished product in UAE PSN business unit was about 45% higher, with utilizing the same sort of raw materials (i.e. Protection relays, terminals and all other materials which would be used in Protection and control panels) which have been supplied from one source.

According to all above mentioned, cost overrun and late deliveries in PSN business unit projects was common problem due to presented the negative growth of revenues, market share, customer satisfactions and project margins and if there would not be an appropriate action plan to identify the root causes of problem and improve the existing situation, it could jeopardize the future of entire business unit

The next step which is first step of 4Q process – measure, would focus in PSN business unit major KPIs and measure the existing situation. PSN business unit major Key Performance Indicators (KPI) will be presented in some of existing projects (e.g. % On Time Delivery (i.e. %OTD), Trough Put Time (i.e. TPT) and Total through Put Time (i.e. TTPT) in order to understand the output of existing processes..

5.2 Q1- Measure:

One of the key tasks in the first quadrant (Q1) was to identify of PSN KPIs, i.e. TPT and TTPT and OTD for a typical PSN project in order to measure the level of improvement in next steps. So, the author collected some data relevant to last 11 projects in PSN business unit.

In order to understand the inside ABB terminologies and business, we will briefly discuss about the above mentioned KPIs and define them before presenting the KPI figures in previous project.

Fig.5 shows the entire business process view in PNS business unit which includes; Sales/ bidding – at this stage the sales and marketing team bid for substation automation projects through sales process which will reviewed and analysed later in this chapter and starts with receiving Request for Quotation (RFQ) from customer and ends with handing over the order to project team.

Then project execution starts with involvement of project management team for overall execution of project and supply chain management team, design/ engineering team, production/ manufacturing team and finally by test and commissioning team in different stages.

Engineering team design the project as soon as project team take over the order from sales team – the design will be done in two stages (i.e. base design and detailed design) and each stage requires approvals from customer, and then supply chain management team start to purchase the required materials as soon as getting bill of materials – which may be generated in different stages, by design team.

Once design got approved by customer and all ordered materials received in factory, production team starts assembly, wiring and testing the panels according to approved design/ drawings. The next work is integration test and factory acceptance test (FAT) which happens with presence of customer witness and after incorporation of factory acceptance test comments - if there is any, the panels are ready to dispatch to customer sites – deliveries happen after getting dispatch clearances (DC) from customer.

After delivery and installation of panels, test and commissioning team will test and commission the entire substation protection and control automation system at customer sites based on as manufactured drawings and make substation ready for energisation. Once substation energized, the Provisional Acceptance Certificate (PAC) will be issued from customer and As Built Drawings will be submitted to customer and the guarantee period starts – which is normally one year. Finally, at the end of guarantee time Final Acceptance Certificate (FAC) will be issued by customer and project will closed in ABB.

So, according to mentioned summary, total delivery time (TDT) starts from getting RFQ from customer till project FAC issuance and delivery time (DT) is the period of time between getting purchase order from customer till project PAC issuance/ substation energisation. Total through put time (TTPT) is the period of time from receiving the purchase order from customer till delivery of the product to site/ Installation of panels. And through put time (TPT) will be the time of manufacturing (i.e. assembly, wiring and factory testing time).

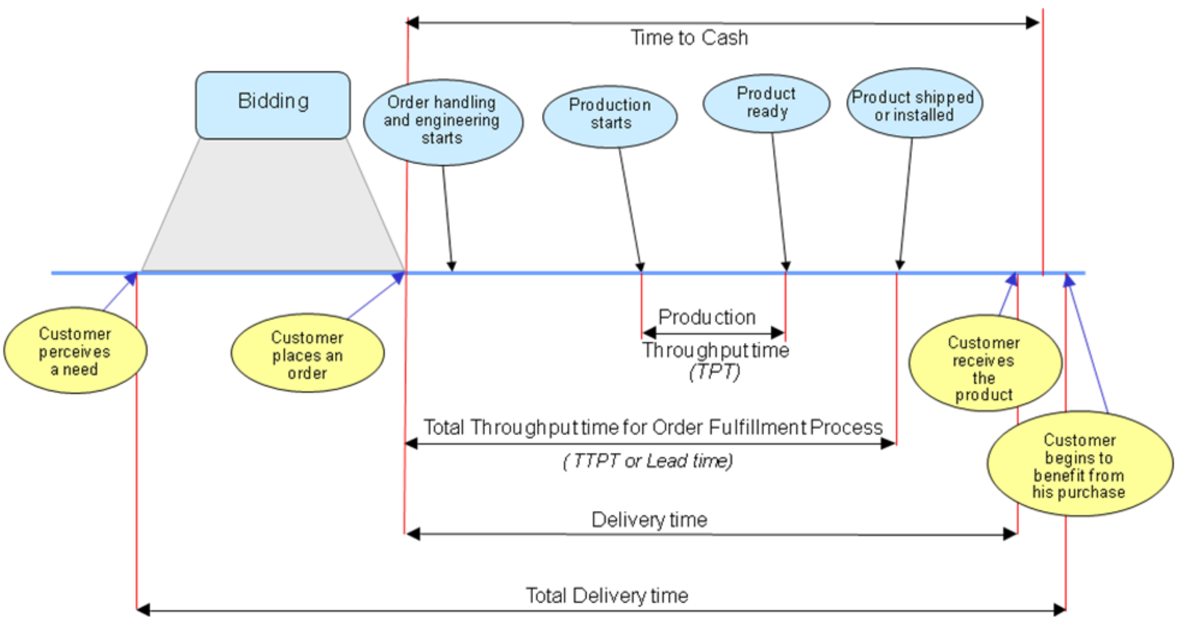


Fig.5

As mentioned already, KPIs in PSN are; Through Put Time (TPT), Total through Put Time (TTPT) and Percentage of Customer on Time Deliveries (%OTD). Fig 6, 7& 8 show the PSN KPIs in some of previous project as sample.

Fig.6 shows the %OTD of 11 projects which all of them has not been delivered to customer 100% on time. So, it means for any reason, PSN has always late deliveries to customer.

And fig.8 shows the TPT per calendar days – from starting of production of panel still readiness of panels for FAT.

As average of presented data in Fig7 & 8 - Table1 presents the “As is process” in PSN business unit based on above described business processes for a typical project (e.g. New Namia substation - A3900 project) with 12 Panels including 2 nos. of Incoming Cable feeder protection panels, 3 Nos. of Transformer protection panels, 2Nos. of Bus Section Protection Panels, 1 no. of Transformer Interlocking panel and 4nos. of Bus bar Protection Panels.

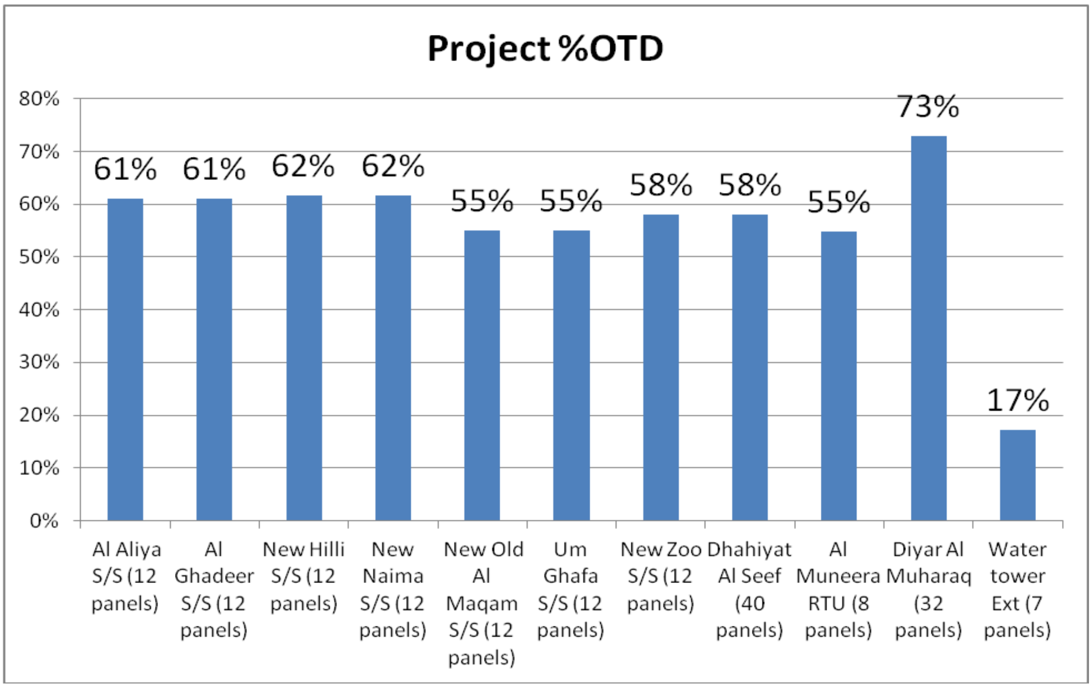


Fig.6

Fig 7& 8 show the statistics about TPT and TTPTs – per calender days, of same projects. Fig 7 presnets the differences on contractual TTPTs and Actuals as well.

5. Analysis

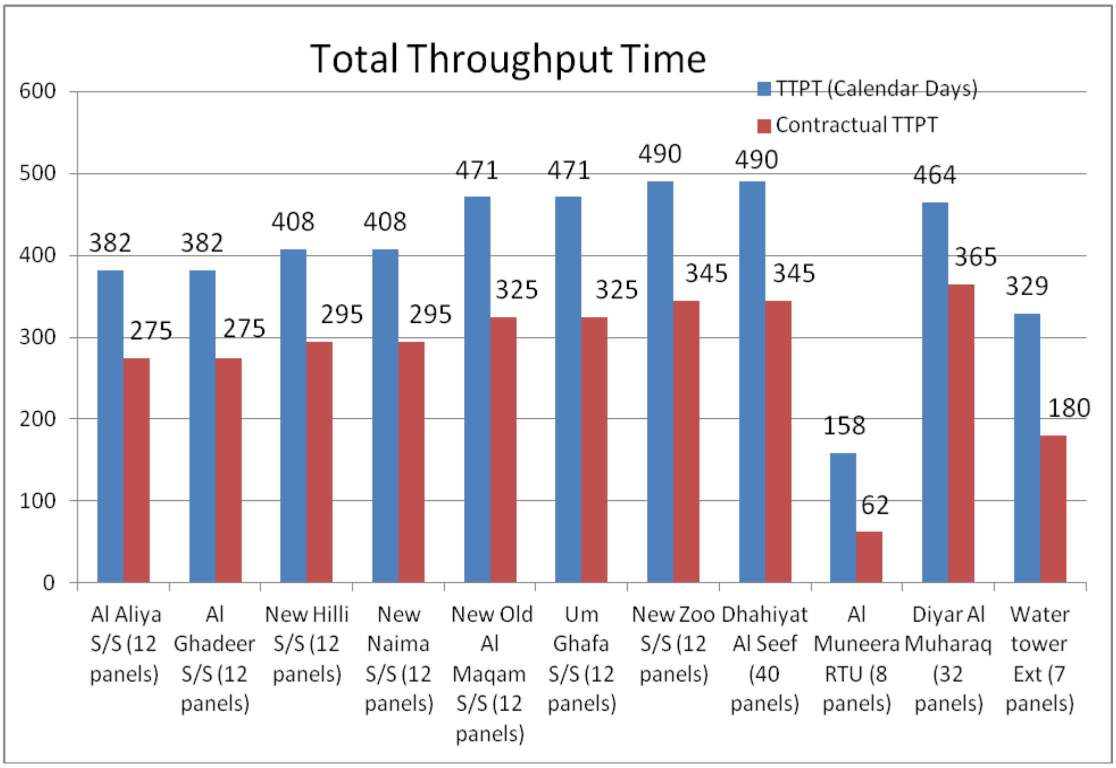


Fig.7

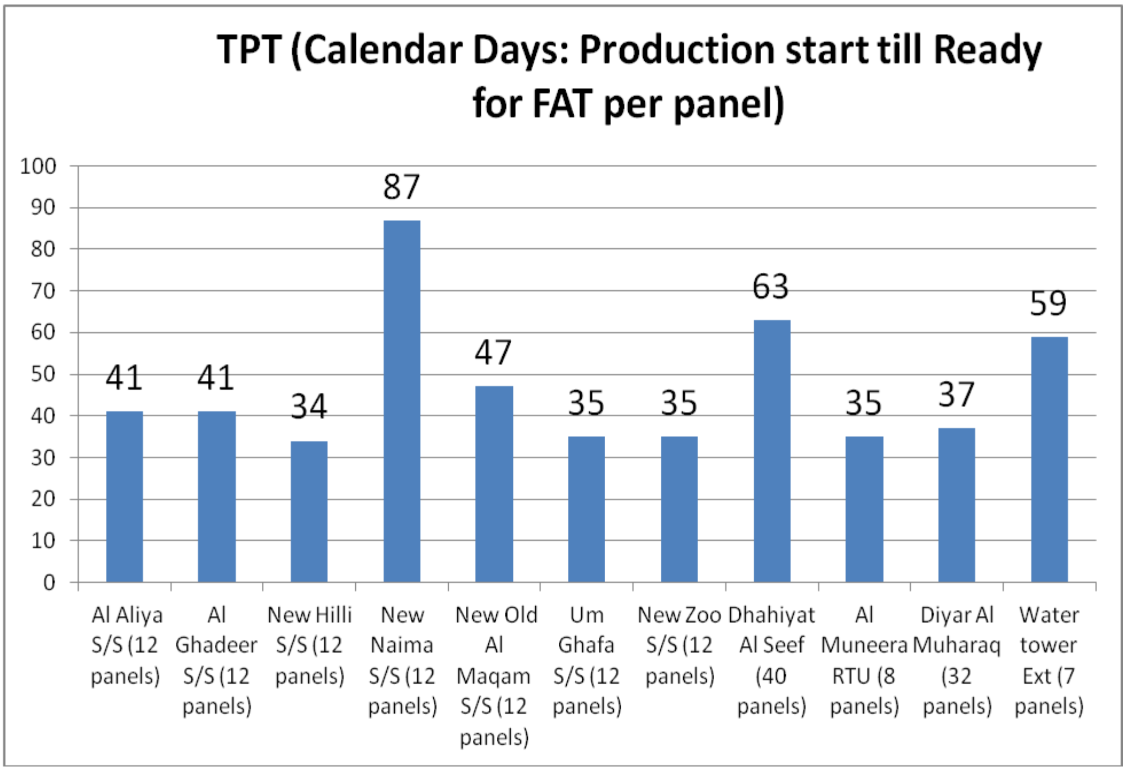


Fig.8

The project manager will be involved once project awarded to ABB – PSN and then handing over from sales to project would take place in 3 days. Design engineer and Drafting team also will be involved in project at the same time and the design will be done in two stages (i.e. base design and detail design) but in each stage customer approvals are required which approval durations differ project to project. Typically the approval durations are three weeks but usually, it takes longer time. In typical project we should consider one approval time in base design and two approval times in detail design stage. After submission of FAT reports as well there would be about 2-3 weeks customer approval for review and approving the FAT test reports and issuance of despatch clearance for the panels. In total typically 82 days would be considered for customer approvals.

As it is shown in table1, the TPT for typical 12 Panels is 45 days (i.e. 1.5 months) and typical TTPT is 356 days without consideration of Customer approval times (i.e. 51 weeks or 12 months). And typical delivery time of project is 528 days (i.e. 75 weeks or 19 months) while the desirable time for customer is; one month for TPT, 8 months for TTPT and 12 months for project delivery time.

According to Fig.6, the average rate of % OTD in PSN business unit is about 59% and the target %OTD was 100%.

So, according to brain storming – Philosophy has already been described in methodology chapter - session results which were “Brink of Chaos” in PSN business unit and all above shown results we found out that we have to produce and delivery of same type of product in shorter time (i.e. almost 40% less time). This means that we had to review and improve the functional existing processes in order to achieve the targets.

So, on Q2 the researcher would review and analyse the existing processes in order to find out the weak points and bottle neck problems.

5. Analysis

Resource Involvement		Project Task	Duration / Days
Project Management	Sales Person	Customer Award the contract to ABB	1
	Sales Person	Project Hand Over from sales to Project	3
	Design engineer / Draft man	Design - Base	195
	Design engineer / Draft man	Design - Details	
	Purchasing officer	Procurement	112
	Production team	Production	26
	Production team	Internal testing	7
	Production team	FAT + FAT comments incorporation	5
	Production team	Packing & dispatch	7
	-	Waiting for Customer Approvals in different stages	82
	Commissioning Team	Test & Commissioning	90
Typical TPT			45
Typical TTPT without Customer Approval time			356
Typical TTPT with Customer Approval time			438
Typical DT			528

Table1

5.3 Q2 – Analysis of Existing Management Processes:

There would a description about each process of PSN business unit, in order to review and analyze the existing processes easier.

1- Project Management Processes

Project Management in ABB – PSN, is the task to manage the application of knowledge, skills, tools and techniques to project activities. This includes delivery of the As Sold scope to the Customer and the budgeted revenue and margin to the company. Project management begins with the involvement of a Project Manager once Purchase Order (PO)/ letter of award (LOA)/ letter of intent (LOI) received from the client/ Customer and continues, through project execution, installation, commissioning, and warranty period. Much like any other business management, this requires management practices, overall control, and the ability to allocate and delegate the project effort to various specialized functional areas.

Project activities are highly dependent on the scope and nature of a project. The applicability and order of different tasks may differ. Several tasks are performed simultaneously (in parallel) and repeatedly throughout the project execution. The Project Management function is performed by an appointed Project Manager (PM) or other person responsible for managing the order.

According to project management process – Process1, the Sales process has been completed and the order received from the Customer. The Project Manager takes accountability and ownership of the project. And some key activities as described below would happen in project start up duration after development of Project Team from different functional units.

1.1 Contract Analysis starts with project internal kick off meeting- The PM take the responsibility for the contract. If there is any doubt whether all contractual aspects including; Terms and Conditions, Schedule and Cost, as well as technical matters reviewed during the sales stage, this must be verified now. The result of this activity is PM’s final acceptance of the contract (i.e. “As sold” version), sign off the hand over document and handing over the project from sales team to project team. Project summary information is compiled in a Project Description.

5. Analysis

The intention with this analysis is to verify that all elements required for predictable and successful project execution have been/are covered and the deviations would be highlighted in project external kick off meeting with client/ customer. Relevant actions are;

a. Review all relevant documents in the Order Package, received from the Sales process.

b. Review the Handover Checklist as filled out through and received from the Sales process.

c. Review the received purchase order/contract and compare it with ABB's proposal/as sold specification.

d. Verify that labor estimates for engineering, installation, startup, project management and other functions are valid, and are based on the "As sold" scope.

e. Verify that the project financial plan has a positive cash flow or that allowance for cost of interest is budgeted for.

f. Verify that the contract is based on ABB's General Terms and Conditions, or approved by Legal.

g. Review Risk Review Report as received from the Sales process.

h. Verify that payment milestones are reasonable.

i. Verify procedures for Contract Changes.

j. Develop a Basic Project Schedule and confirm the milestones with Client in External Kick off meeting.

k. Work Breakdown Structure (WBS) developed and/or refined.

1.2 Once the hand over is over and the technical deviations and commercial issues clarified internally and externally, the Order Acknowledgement would be generated and sent to the Customer. An Order Acknowledgment, based on PM's input as part of the order entry documents, is generated by sales team. Otherwise, there would be amendment to the PO/ LOA. The PO/ LOA would be entered into the business system (i.e. Enterprise Resource Planning (ERP) system), by order administration as instructed by the Project Manager. Cost report line items and milestones are set up.

1.3 Make sure different functional units are working as planned (e.g. meeting the planned project milestones). The first milestone in PSN project execution is submission of Base Design to customer/ client. Base design will be prepared by design team released for submission by design manager and submitted by Project Team. Usually there would be 3 to 4 weeks in PSN contracts for customer approvals after any submissions, but the common issue is getting approvals/ comments in longer time. Another common issue is resubmission of drawings more than once. (i.e. it cause reworks with including cost and time impact on project). Getting approvals will be a trigger to release the bill of material/ quantity (BOM/ BOQ) of long lead items. The BOQ will be prepared by engineering function and through the PM will transferred to supply chain management team to proceed the purchasing of long lead item. At the same time, the engineering team will proceed on generating of Detail design drawings and documents. The same approval/ commenting process from customer/ client would be applicable (i.e. 3 to 4 weeks to comment/ approve the drawings and if any resubmission required, the engineering team will incorporate the comments on the project design). The final approval will be trigger to release the BOQ of rest of required materials. The same activity will be practiced by supply chain management team. All of these activities would be proceed through PM.

1.4 Work order would be issued to factory once the detail design drawings got approval by PM.

1.5 Project review including; project risk & opportunity reviews, financial reviews and changes will be covered in monthly basis by PM till project close out stage.

1.6 Rest of the steps in presented process1 is in line with PSN business steps which have already described in Q1.

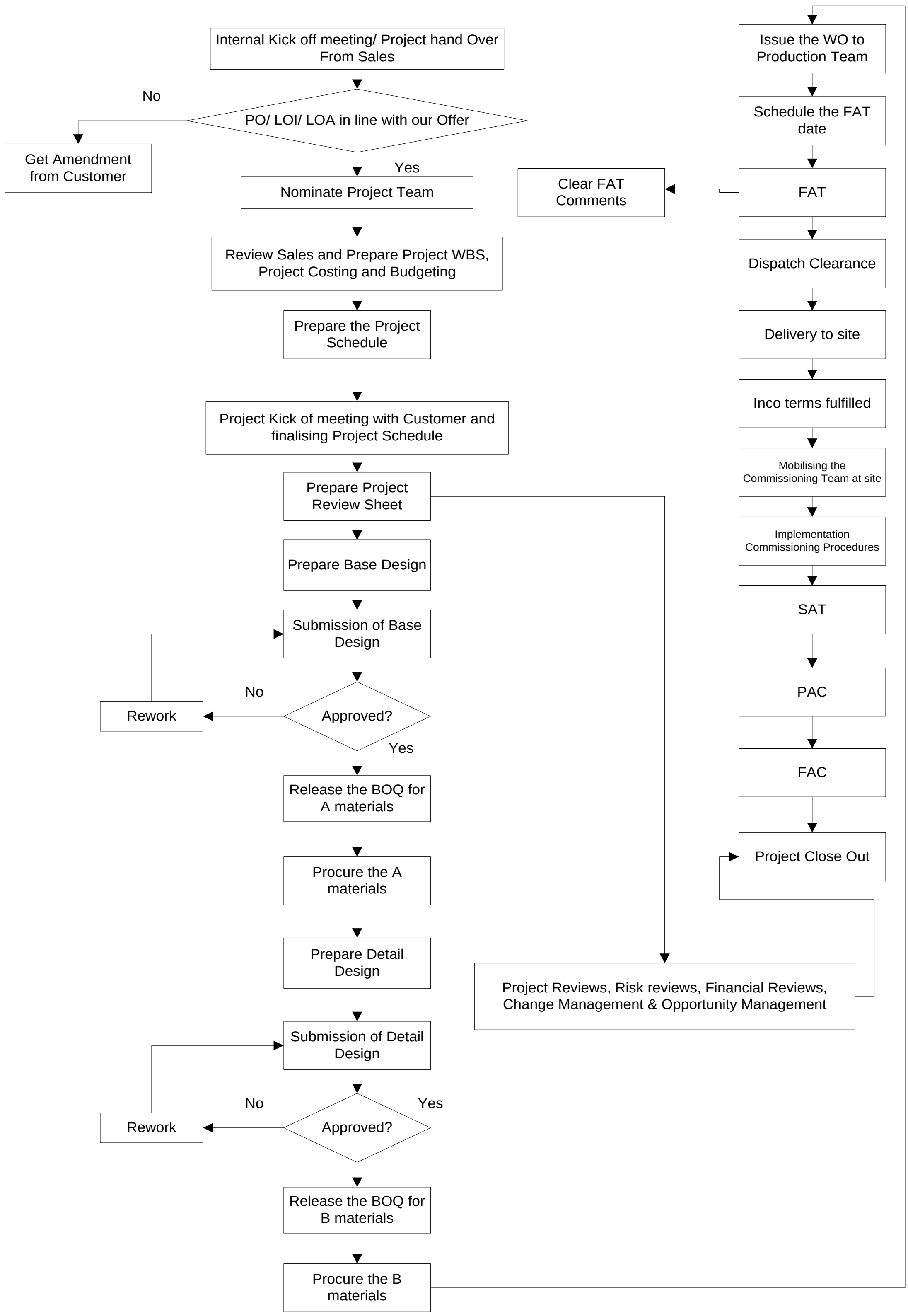
In summary, PM is involved in all project activities according to process1, while according to project management definition in PMI; technical involvement of PM is not required. Looking in depth at presented prcess1 highlighted that there are lots of steps in the process1 which in no taking place by PM. The PM role is only making sure that all functions are working together and project is moving on time and in budget. In other word, the major project management responsibilities which are; risk and opportunity management, change management, financial management, monitoring and control the project and … have been shown in some limited block.

In addition, the result of interviews with PMs at PSN business unit regarding the project management role indicated that most of people do not have clear understanding of their roles and responsibilities; the same confusion was among the project team members. One of the common issues was drawing submissions to customer which was different project to project. For instance in project A the PM was submitting the drawings and follow up the approvals while in project B all these activities was taking care by engineering team.

Furthermore, regarding the original project management tasks (e.g. risk management, change management, scheduling, reporting and etc) each project manger had their own way to cover the task. The lack of separate processes for managing change orders/ variations or risk & opportunity management process was one of major issue in PSN business unit. And this problem could have been bigger and deeper if the project manger was not available for while (i.e. the PM could be replaced or resigned). The tracking of change orders was almost a nightmare for next PM.

Another issue was related to hand over stage which was happening between sales team and project team. Usually the "As Sold" version of project was quiet different than the actual one in terms committed dates and technical specifications. It could cause conflicts between sales and project team. Since the as sold version was outcome of sales process, the issue will reviewed in further details later.

In addition, there was a huge communication gap among the different functional units which should be covered by PM only since each functional unit worked as a separate Islands and the only communication among them would take place through emails. There was no frequent face to face meeting among project team. So, nearly all the time PM was busy to transfer information from one functional unit to another one. For instance design engineer was waiting for marked up drawings from factory team for long time, but he never asked directly from factory engineer for drawings since "I did not know that to whom I should ask" according to design engineer. Or "I do not know who is responsible for project X in factory".



Process1 – Project Management Process

Another outcome of lack of communication was inappropriate planning in terms of resources and time during the project execution in different functional units. For instance, usually the work order would be issued to factory for project X after getting approval on detail design (i.e. almost in middle of project execution duration) and production/ factory team will be engaged in the project in quite late stage in terms of planning. And in most of the time, “I do not think that I can meet the given deadlines” would be the first reaction of production manager to PM. Or “my team are quiet busy and I canot distract them now. So, your project will be in the queue. I will do my best, but if I knew that new project is coming I could have planned better” or “there are some people on annual leave and they will not be available by next month, If I was aware about coming load I could have some more people here”.

2- Sales Process

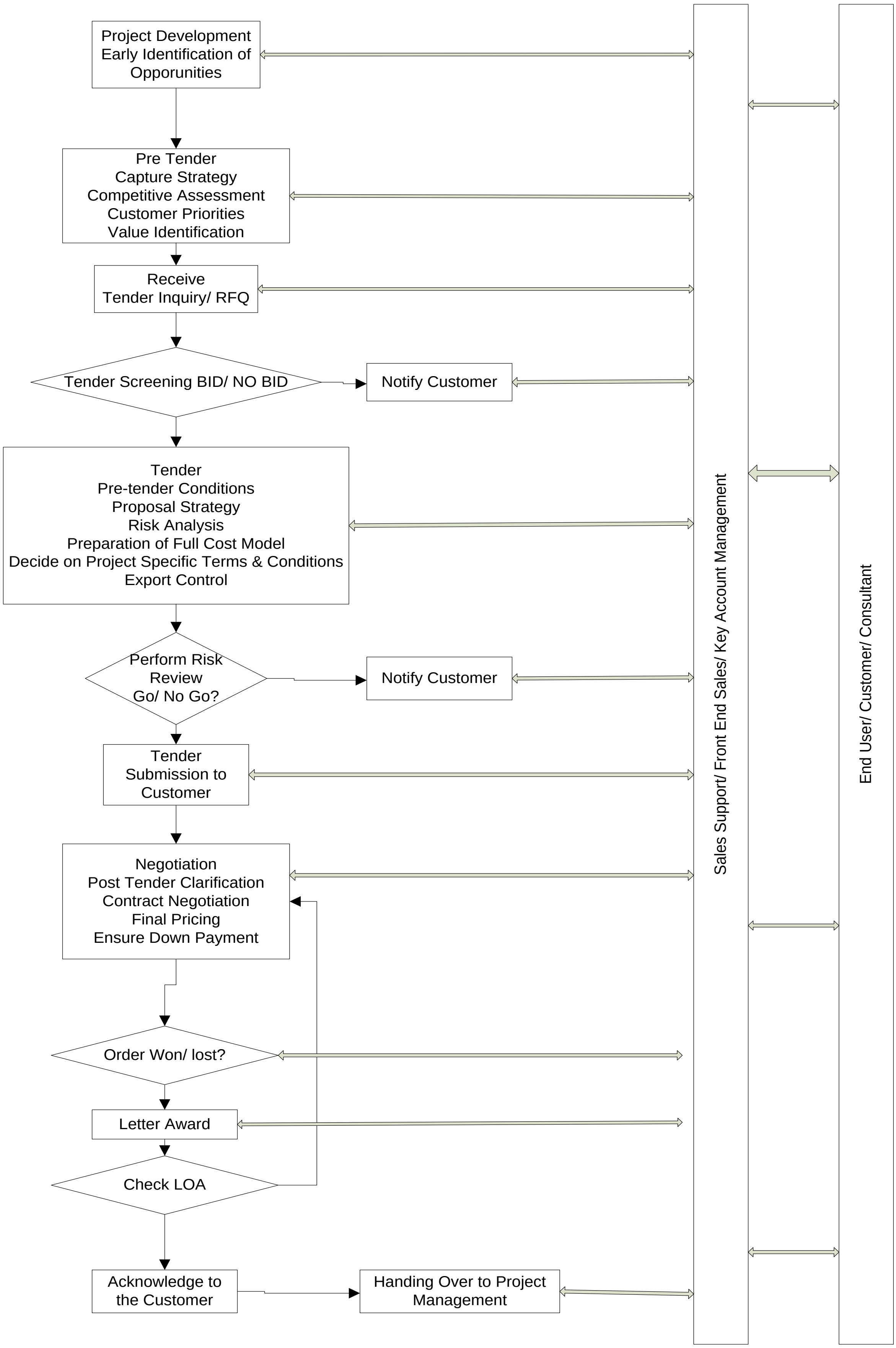
According to process2 which presents the sales process in PSN business unit, the sales team after identification of opportunities in the market, capturing the strategy periodically and receiving the enquiry from Customer, would do bid/ No bid decision through the screening the tender document and in case of attending or not in the bidding competition a relevant notice will be submitted to the client.

Then in the next step full cost model for project will be prepared and risk review will be done for projects which the estimated contract amount would be higher than XXXX USD (i.e. risk review will not be done for each and every project in sales stage).

After submission of tender document to customer, there would be negotiation step with customer relevant to contractual, delivery terms, payment terms and so on. And after getting feedback from customer in terms of win or lose the tender or getting LOA, the order acknowledgement will be submitted to customer and the received order will be handed over to project team. It should be considered that all sales communications with customer will be done through front end sales team.

What is clearly missing in the presented process, is lack of communication with other functional team like engineering in terms of preparation and submission of technical offer and project management team.

5. Analysis



Process2 – Sales Process

5. Analysis

Sales team works independently with involvement of other teams; it means the lesson learned of previous projects will not be taken care in upcoming projects. For example technical solutions which have been achieved in earlier projects which got huge amount of time in terms of customer approvals and cost impact in projects as variation order, would not be considered in new projects. And new project team have to repeat entire loop to achieve to the same point. For more clarification, project A got; some specific type of equipment which have been agreed with customer after long time and so many design changes have been accepted by some specific customer for project A. Sale customer send and enquiry for PSN sales team and ask for similar scope of work for project B and their assumption is what they will get as project deliverable in project B would the finished good (i.e. after implementation of all design changes and material changes), but since there is lack of communication inside ABB PSN unit among Operation team and sales team, the estimated price will be the same amount of initial amount of project A not the final one. And, consequently, project B have to repeat the same experience of project A in terms of cost and time impacts which mean lots of reworks and poor quality of project management plus customer dissatisfaction.

The other major missing item is planning of resources for upcoming projects. In other words, functional manageress who should take care of resource planning for the entire unit cannot have proper planning since they would not have idea what are the upcoming projects and the amount of upcoming work load. So, the common issue in projects is; shortage of resources in engineering, project and so on. “If I was aware that project X will be awarded now, I could have planned my resources better” engineering mangers said once project X had been awarded to PSN business unit. Or “my team are already overloaded and I canot force them to work more, I have problem to nominate any design engineer or draftsman for this job. All are busy”, or “sales team has committed for application of new technology in new project design while, there no skilled design engineer for that job, they should be trained for application of new software and the training is not available here in UAE, I have to send some of them for overseas training to be skilled enough”.

The third issue was related to lack of post tender analysis. There was no post tender analysis to find out the root causes of winning or losing the job. This could be used inside sales unit for next tenders as lesson learnt.

The final point was related to Risk review of tender document which was i snot applicable for small projects. Since the risk review meeting committee are country manager and division manager and it is time consuming procedure, it is not applicable for contract amount below 5MUSD, and mostly PSN business unit contracts are below than specified amount, so, risk review would not be applicable for tender preparation of all PSN projects in sales stage. The result would be uncovering of some risks and reduction of project gross margin at the end of project.

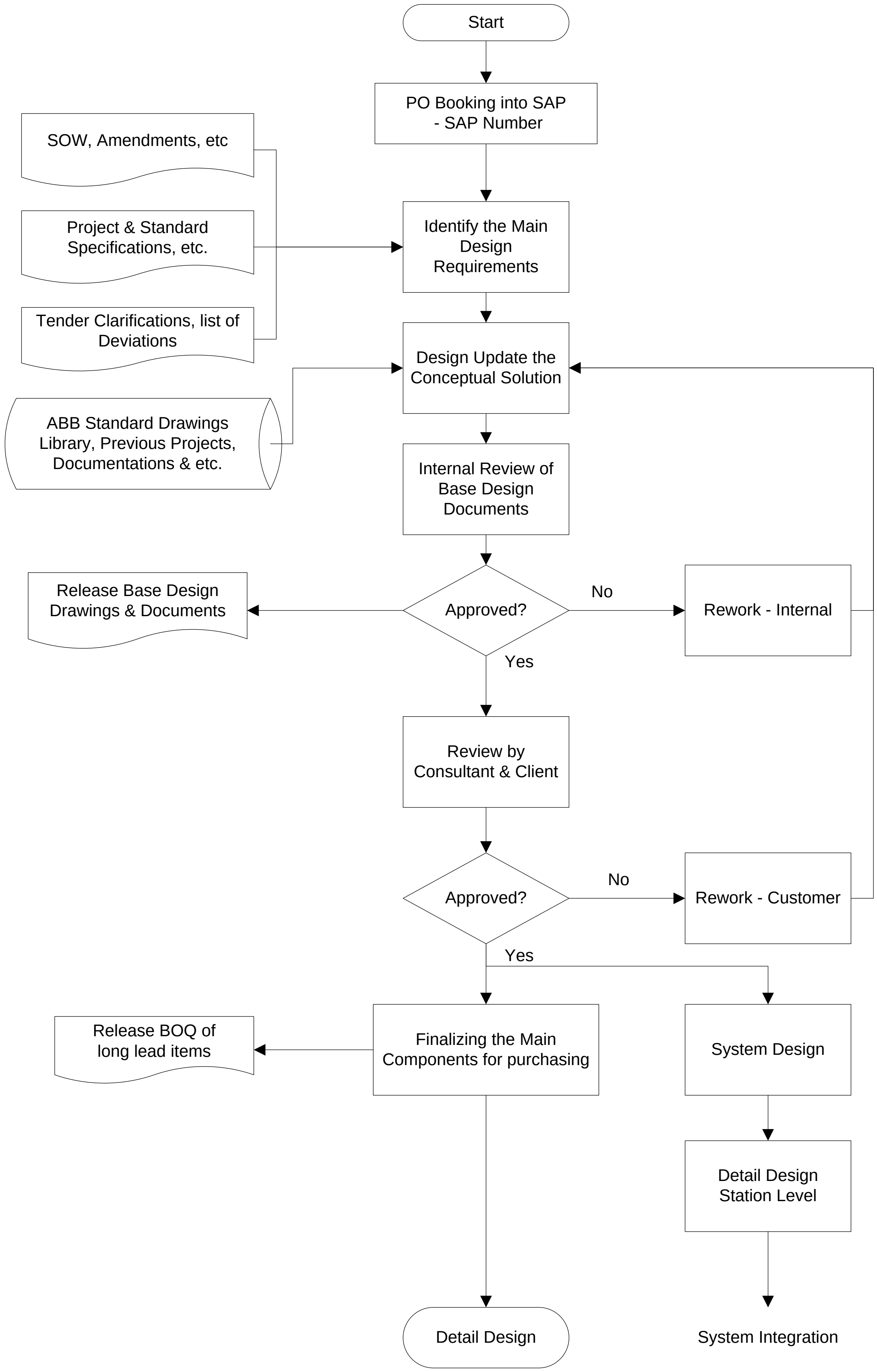
3- Engineering Process

Presented processes as process 3 and process 4 are related to Engineering process in PSN business unit in ABB UAE. Process3 is applicable for base design while process4 presented for detail design engineering job. The presented processes were better in terms of output and sequences and the concept of activity which are totally related to engineering job and would be taken care by design engineer and draftsman. The major missing part was interfaces with other steps of projects.

In PSN business process, as already have been described earlier in this section, the output of base design process generated based design drawings and documents which will be submitted to Customer / Client for their review or approval and then bill of material for long lead items which will be taken care by supply chain team. In that stage design team should interface supply chain team through project team. It means all interfaces would be covered by project team and there would be no direct communication between two functional units. Even though technical clarifications before placing the order to suppliers/ manufacturers was one the most critical issues in PSN business unit. For instance, the panel general arrangement drawings should be generated by design team in order to get the quotation of control and protection cubical, the drawings should cover all project specific requirements like, colour code, dimension, side views and etc. and supplier would submit the manufacturing drawings which have been generated by themselves to ABB. The manufacturer contact point in ABB is procurement officer which is not a skilled person to check and confirm the received drawings. So, that activity should be taken care by design team during the placing order for all required materials while it has not been covered in engineering processes.

The other interfaces which should be taken care by design team is engineering support during the wiring, assemblies and integration test of all control and protection system in manufacturing process and site works. As already described, after receiving all ordered materials and enclosures from different suppliers in ABB PSN workshop, production team could start their work (i.e. assembly of protection relays and control equipment and etc in the panels, wiring the connections between the relays and all other items and integration testing and so on) based on manufacturing drawings and wiring tables which have been generated by design team and have been reviewed and commented by customer/ client (i.e. the output of detail design engineering process). But again engineering support is required by design team to clarify the technical complications during the manufacturing process. The same support required during the site works as well since the workshop team and site work team are not skilled enough to solve the technical problems (i.e. if there is any complication) and moreover, the main protection and control philosophy have been generated b design team. So, if any changes happened during the wiring and integration test in workshop or project site, should be taken care by design engineers and must be implemented drawings or relevant documents. So, additional processes are required for technical support of site works and manufacturing works.

In summary, the interfacing among design team and sales team, design team and supply chain team, design team and manufacturing team and design team and test and commission team should be defined to cover all technical support of project.

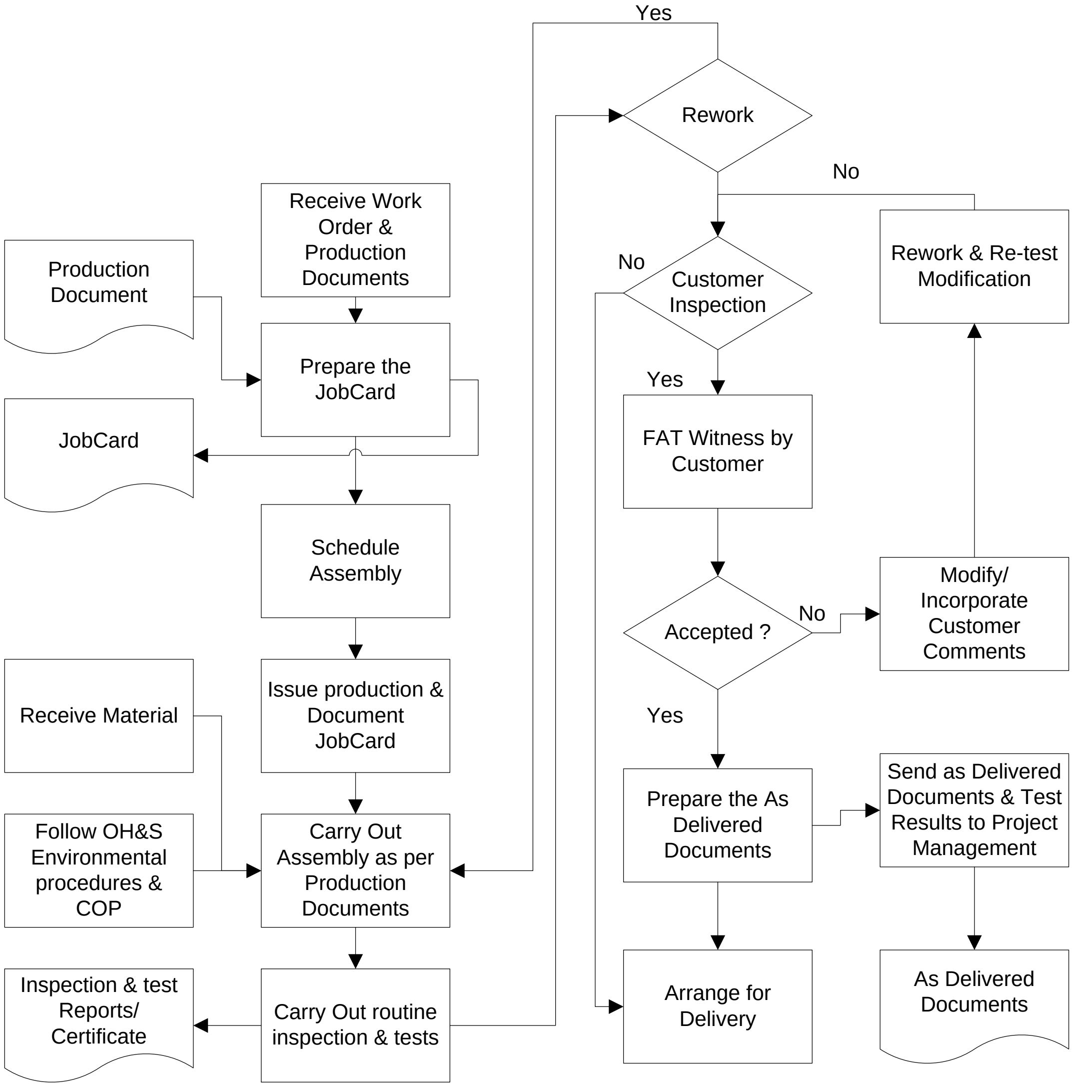


Process3 – Base Design Engineering Process

Process4- Detail Design Engineering Process

4- Manufacturing Process

As already covered in earlier processes, manufacturing process – process 5 - starts with receiving of work order from project management team, receiving of ordered materials (i.e. which have been ordered by supply chain management team) and receiving of manufacturing drawings and wiring tables by design team.



Process5- Assembly and Testing process

The first comment on presented process5 could be missing of start and end block in the process flowchart itself.

In terms of concept, the “As delivered” drawings preparation is not part of manufacturing process (i.e. as already have been explained would be part of manufacturing support work which should be taken care by design team). In other words, the red marked up drawings would be the out put document of manufacturing instead of as delivered drawings.

In general in process is a not very organized sequence. For instance some quality inspections on received material could be added in terms of checking of received quantity (i.e. quantity checking in comparison with placed purchase order to suppliers) or the packing of received materials or etc. if everything is alright the manufacturing process could move forwards to next steps. Otherwise, the issue should be informed to suppliers immediately through project supply chain management team (i.e. interfacing process between manufacturing team and supply chain team is required).

Work order and manufacturing drawings & documents would be separate input for the process. Then the first block of process would be plan the manufacturing which could include resource planning and scheduling of manufacturing. Then issuance of Job card for production team (i.e. as part of process) and then received material quality check. The following steps would be assembly and wiring of the panels. In this stage the close communication between design team and manufacturing team would be required since manufacturing team's work basis is the drawings which have been generated by project design team. So, any complication or confusions could happen during the assembly or wiring works (i.e. the necessity of manufacturing support process by project design team to cover the design and manufacturing interfaces).

Inspection test plans (i.e. ITP) which are output document of manufacturing job and should be approved by project customer is the next block of process. If the submitted ITP got approval from the customer, work could carry on to Pre factory test block and then factory test will be done with customer witness and test reports would be submitted to customer for approval or comments. If there is no comment on test reports, then customer should issue the dispatch clearances and then delivery the panels to customer sites.

The logistic part of projects will be taken care by supply chain team as well (i.e. arranging the transportation company to deliver the panels from ABB factory to project site). So, close communication between factory team and supply chain team would be required to cover the interfacing process once again.

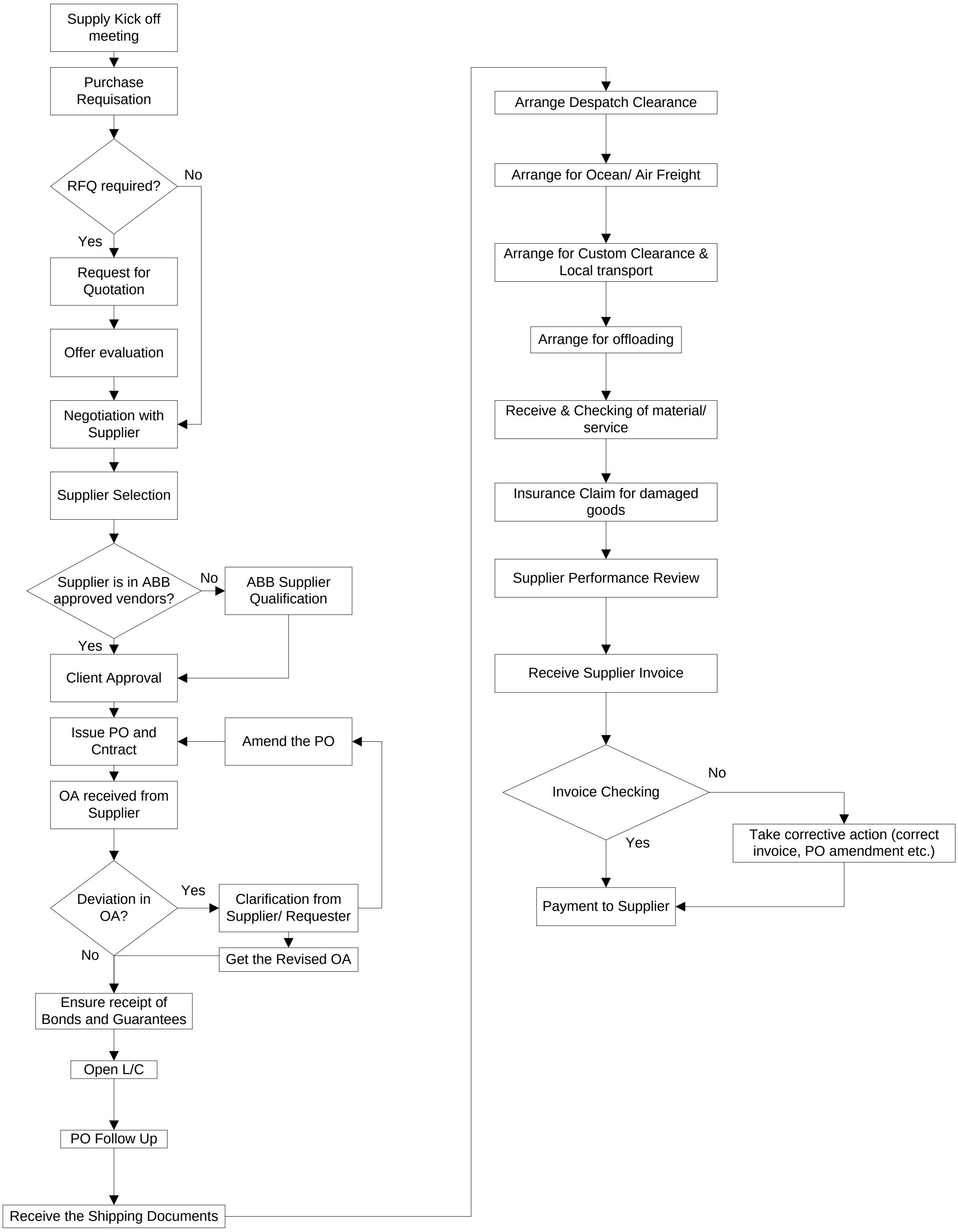
After delivery and installation of project deliverables to site, site acceptance test will be done by test and commissioning team at project sites. In ideal situation, the site test and commissioning team are the same as factory test team (i.e. it would be great if same team do the site test and commissioning work since, they could handle the job faster due to their awareness about job). Site support process would be required at this stage by project design team (i.e. as already mentioned to cover the interfacing between test & commissioning team and design team.

5- Supply Chain Management Process

Process 6 presents the supply chain management process in PSN business unit which starts with raising the purchase requisition (i.e. PR) for all required materials by project team (i.e. based on received BOM from design team). And continues with getting quotation from suppliers, offer evaluation, issuance of purchase order to suppliers, getting order acknowledgement from suppliers, delivery of materials to ABB workshop and finishes with payments to suppliers.

The first comment for presented process would be missing of start and finish blocks. And the next comments would be missing interfacing processes with design team and manufacturing team which have been described in earlier parts of this section (e.g. suppliers' technical offers should be evaluated by design team and the quality check the received goods should be taken care by ABB factory team)

In addition, according o (Sanayei et al. 2010) supplier selection is a fundamental issue of supply chain area which heavily contributes to the overall supply chain performance particularly for companies who spend a high percentage of their sales revenue on parts and material supplies and whose material costs represent a large portion of total cost savings from supplies are of particular importance. These, strongly urge for a more systematic and transparent approach to purchasing decision-making especially regarding the area of supplier selection. Selecting the suppliers significantly reduces the purchasing cost and improves the corporate competitiveness and that is why many experts believe the suppliers' selection is the most important activity of a purchasing department. Supplier selection is process by which suppliers are reviewed, evaluated and chosen to become part of the company's supply chain. The overall objective of supplier selection process is to reduce purchase risk, maximise overall value to the purchaser and build the closeness and long term relationships between Byers and suppliers. So, the supplier selection process should be more specific process in ABB PSN business unit as well.



Process 6 – Supply Chain Management process

In summary, ABB PSN business unit existing processes have a technical and productive structure with less sufficient efficiency, although, ABB have a qualified labour force. It was necessary to complement the learning strategy and the research and development efforts in high priority functions in order to generate the knowledge required to achieve an effective assimilation of the advance in technology use and to facilitate their adaption to the local condition. It involves creating the conditions that permit optimisation of productive efficiency, so that greater competitiveness of local market could be generated. In this sense, the need for the constant development accompanied by new methods and management styles become issues of vital importance.

The above analysis highlighted that the common issue of existing processes are miscommunications among the different functional units while as (Terwiesch and Loch, 1999) mentioned; frequent communication and contacts between engineering groups and manufacturing groups and project management team with a clear communication protocols and clear responsibilities make communication easier.

According to (Merwe, 2002) functional management has formal responsibility for defined organizational outcomes; they have specific resources at their disposal and they are accountable and this accountability cannot be delegated. So, if they could be involved in project earlier stages, they can come up with better resource planning for the project as (Bessant and Francis, 1997) presented in six key design elements in product development which are necessary for implementation of upgraded processes (i.e. in LR section).

5.4 Q3 – Improve:

Analysis of existing processes (i.e. all mentioned in Q2 section) and review of relevant literatures (i.e. in LR section) show that, project managers have delegated resources from across the functions and they are deemed to be responsible for the outcomes of the project. This brings us to realization that the management of processes and projects are interrelated. In fact the process team can be directly equated with the project team (i.e. it should be considered that each functional team has their own requirement and views) in the modelling of the product development process. So the ideal method is to build and integrated model base on multi-view for product development process (Zhong et al. 2005) and it could be broken into sequential stages (Delamaro, 2006).

So, according to fig.1, Q3 of smart execution project includes gate 4 (i.e. redesigning the new set of processes and integrated model) and gate 5 (i.e. validating the model through a pilot project). So, In order to understand the integrated model, stage-gate model to be understand in depth from literature point view and ABB.

Stage-gate process; requires completion of stages before the project can pass through a gate to the next phase of development and it uses functional teams that operate in parallel to reduce the critical path and to better coordinate the later stages with the earlier ones. This process encourages cross functional teaming (Connor, 1994) and provides project teams with a flexible capability for asking the right questions, identifying the major gaps in knowledge and managing the top priority uncertainties much earlier in the development cycle (Cooper, 1993).

So, according to Cooper, stage-gate model is a multi step project management approach of fact-based decision making for use in developing of processes and products. And provides flexibility to gather information, manage risks and address end-user needs in the timeliest manner.

Stages are the elements of process which work should be performed and gates are decision making point in order to move the next stage. And each stage has a set of qualitative/ quantitative criteria which should be met before moving to next stage. Stage-gate model could lead to higher percentage of successfulness in project management by enabling effective communication among the project team and functional manger. Moreover, a well-implemented project decision making process can shorten the time of project by 30% or more.

So, in order to improve the overall quality of the engineering deliverables and consequently all process related steps like; procurement, manufacturing, testing and commissioning in the projects, some critical check points has been defined (i.e. Gates) in the integrated process flow to assure completeness, consistency and quality of required project data and deliverables. This change could reinforce the established interfaces between engineering, manufacturing, Testing, Commissioning and supply chain management functions at PSN business unit and accentuate the critical Engineering process steps from takeover from Sales till the handover to Service. This change would lead to reduce the amount of reworks in each functional stage and improve the project lead time and therefore maintain the project margin.

5.4.1. Smart Execution Integrated Gate Model:

A gate verifies if project is ready for the next project phase with/ without taking corrective actions (i.e. Are all required information, documents, data, etc. available to continue?, Are all defined and necessary project tasks done to continue?). In other word, gates are decision points to determine whether to continue the project based on its benefit, status, risk, resource and technology considerations or are milestones which show how far a project has progressed against the defined criteria. ABB Engineering gate process model has presented in fig.9.

A gate owner is typically the manager of the business, who will take over the project result and drives gate decision based on relevant facts. Gate Assessor is someone who is aware of the gate model and provides an opinion and explains the facts considered in the gate decision and a Gate Coordinator - who usually is a technical person, initiates the gate and assures proper gate process within the project considering all technical aspects. Additional gate Participants (i.e. all project team member are from different functional units) Support and drive decision.

5. Analysis

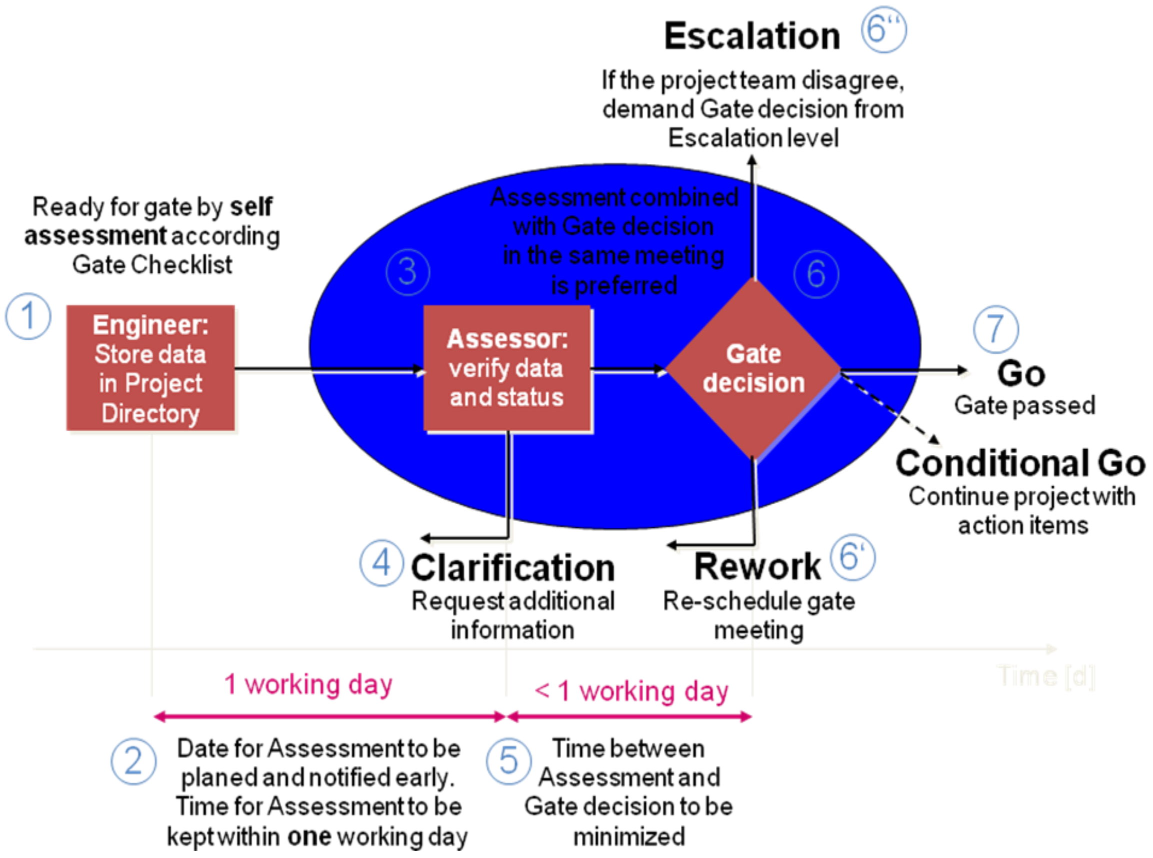


Fig.9 – Gate Process

The Gate Owner is responsible for controlling the project from a business perspective including starting, stopping and changing the goals of the project. The person should be the person who has the most benefit from the project management results and in most cases is the project manager. Select qualified Assessor, Agree on time schedule, Monitor planned Gate dates, Prepare Gate Checklist, Lead Gate Meeting and decision taking and Give feedback regarding assessment.

The Gate Assessor who normally is the Group Leader or Operation Manager ensures that all of the information needed for decision making is available and evaluated. He/ she nominates additional Gate participants as need arises, Evaluate the available Gate decision material by reviewing it with additional Gate participants and the Technical Project Manager, Document Assessment findings, Express personal recommendation regarding Gate decision, Provide arguments and alternatives and Participate in Gate Meeting and present decision recommendation

Gate Meeting Participants - Gate Meeting Participants help to assess the project performance during gate meetings. The meeting participants should include representatives from each of the major work areas including a member of shop or union management.

Gate Coordinator who usually is a technical manager, trigger Gate decision as scheduled during previous Gate Meeting, Prepare invitation to Gate Meeting as agreed with Gate Owner and Assessor, Distribute Gate decision material with sufficient time for verification, Prepare Action List, Communicate decision taken to all relevant parties and Between Gates, inform Project Manager about issues affecting time plan, quality and costs.

Project Leader - The project leader is responsible for the overall implementation of the project.

The decision making process in each gate meeting will be as below;

1. Gate preparation - The Gate Coordinator plans the date of the Assessment, invites the Gate participants early and makes the Gate deliverables accessible.
2. Self Assessment - The Gate Coordinator performs a Self Assessment with the project core team during project team meeting, prior the planed assessment and documents the result in the Gate Checklist.
3. Assessment - The Assessor and the additional Gate participants review the Self Assessment and check the completeness of the Gate deliverables according to the Gate Checklist
4. Gate decision communication - The Gate Coordinator updates the action list, documents the Gate decision in the Gate Checklist and distributes it to the involved persons.

And the applicable rules are;

1. The Self Assessment shall assure completeness of all relevant project data according gate checklist.

2. The Assessment and Gate Decision shall be as efficient as possible and has to be kept within one working day.

3. The number of Gate participants has to be kept as small as possible.

4. Face to face meeting is the preferred meeting type for Gate meetings.

5. Excessive rework from the assessment findings have to be agreed with the responsible Group Leader.

6. The Project Manager supervises the progress of the actions and updates the Gate Checklist regularly.

7. All Gates shall be documented using the Gate Check List.

8. Conditional passing of a gate with major deviations must be formally approved by responsible department managers.

As already been discussed, fig.10 shows PSN business unit project process overview. Which shows a project process would start from sales process and involvement of engineering function (i.e. once sales team decided to bid for the project) and then project team take over the job for execution. Engineering support will be continued by project close out stage. In execution stage other functional units will support for some period of time then hand over to other functional team (i.e. supply chain management, manufacturing and then finally test and commissioning team).

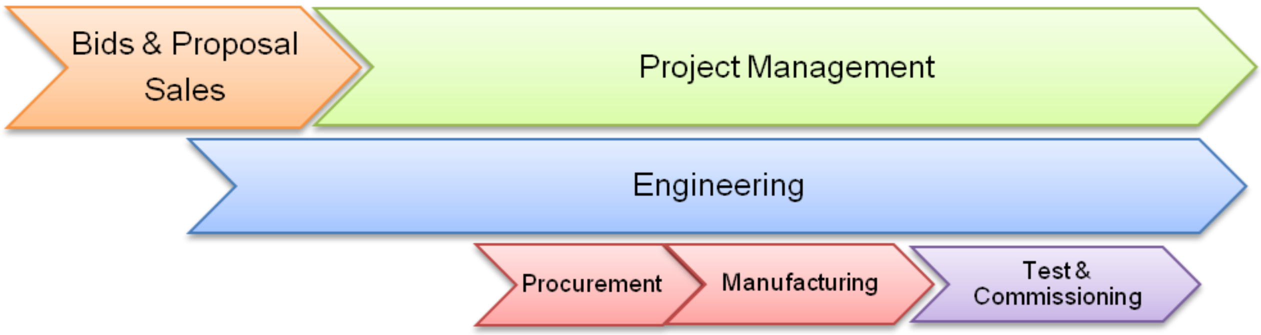


Fig.10 - PSN Project Process Overview

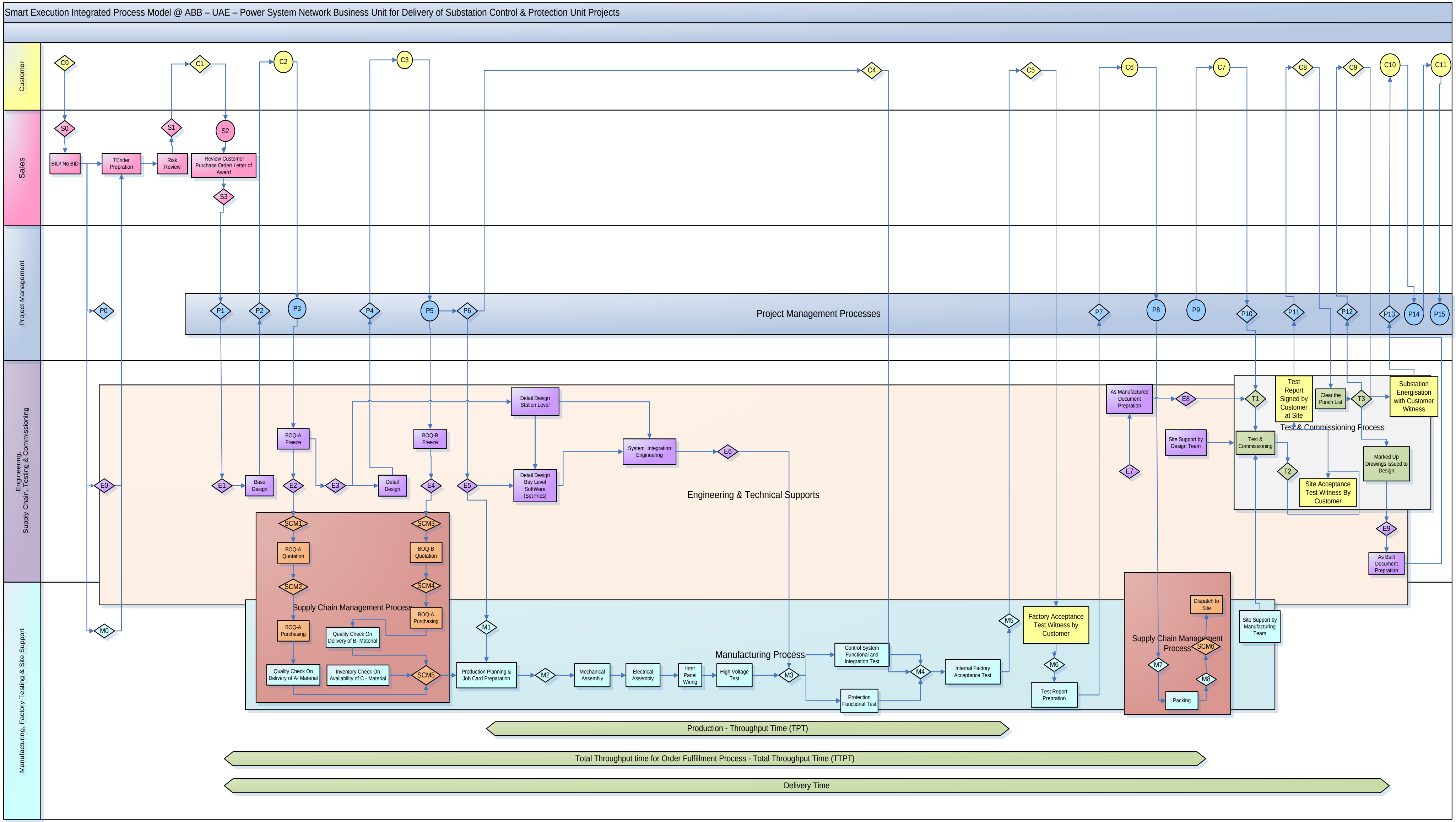
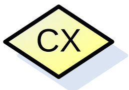
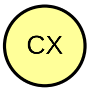
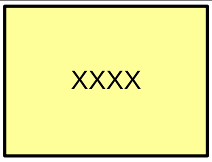
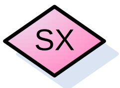
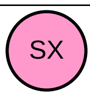
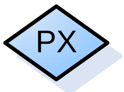


Fig11 – Smart Execution Integrated Gate Process model

Fig11 shows an integrated Gate Model which is outcome of integration of all applicable processes in PSN business unit at ABB UAE. As already mentioned in analysis of existing process - earlier in this section – the major weakness on existing processes was lack of interrelated processes among different functional units like; supply chain management and design team, manufacturing team and test & commissioning team or test & commissioning team and design team. In different stages of project execution close cooperation between two or more functional units are required in order to achieve to the most optimized result in project execution while there was not any clear process to cover the business requirement. The developed integrated model shows the entire process flow of any single project in PSN business unit from start till end which is defined by handing over to service division.

Item	Item Symbol/ Color Code	Description
1		Customer Related Gate
2		Customer Related Milestone
3		Customer Related Process Block
4		Sales Process Related Gate
5		Sales Process Related Milestone
6		Sales Process Related Process Block
7		Project Management Process Related Gate

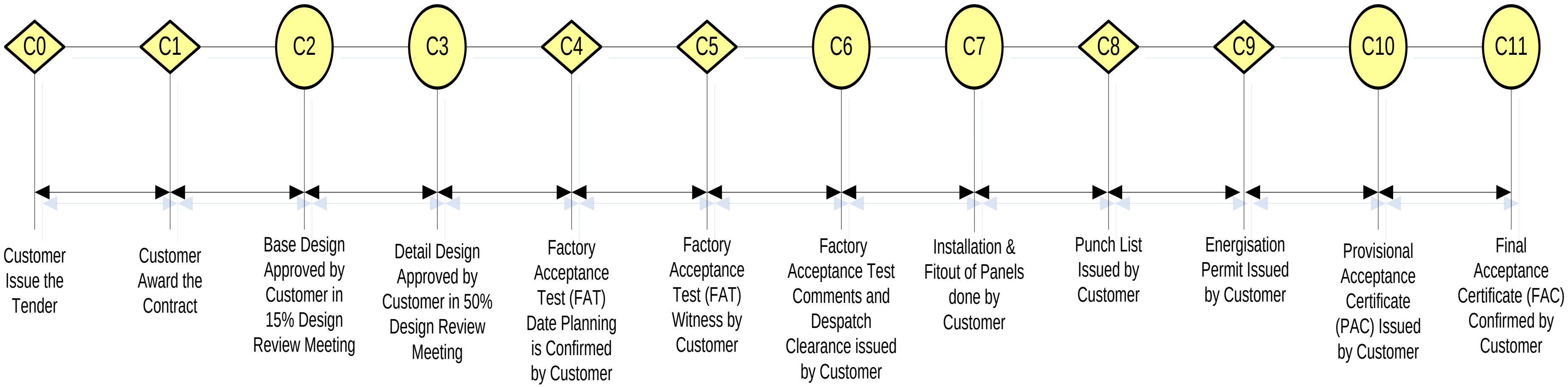
8	PX	Project Management Process Related Milestone
9	XXXX	Project Management Process Related Process Block
10	EX	Engineering Process Related Gate
11	XXXX	Engineering Process Related Process Block
12	SCMX	Supply Chain Management Process Related Gate
13	XXXX	Supply Chain Management Process Related Process Block
14	MX	Manufacturing Process Related Gate
15	XXXX	Manufacturing Process Related Process Block
16	TX	Test & Commissioning Process Related Gate
17	XXXX	Test & Commissioning Process Related Process Block

Table2 – The Colour/ Symbol Code of Smart Execution Integrated Process Model

Table-2 listed the applied color codes of Gates, Milestones and Process Blocks for each functional unit.

5. Analysis

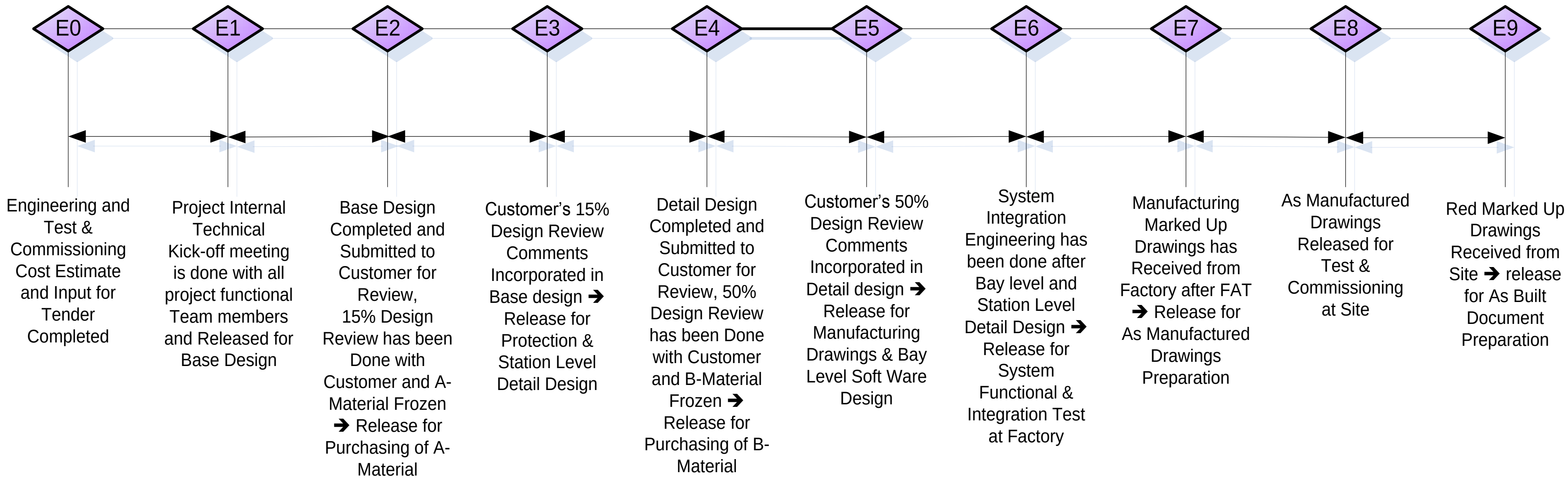
Gate model 1 presents the customer model over view of smart execution process model. The flow starts with issuance of a Tender by Customer and finishes with issuance of Final Acceptance Certificate (FAC). C0, C1, C4, C5, C8, C9 are Decision making gates with attendance of customer representatives and C2, C3, C6, C7, C10 & C11 are project milestones which are related to customer. The deliverables of each milestone are critical for project execution time and any delay would cause delay for entire project delivery time. For instance, C2 & C3 - base design or detail design approvals, would cause significant time impact on supply chain management process and further steps in project design. C6 - issuance of dispatch clearance, would impact on delivery of panels to project sites, additionally would raise space constrain for factory and consequently for other concurrent projects. Any delay in C7 which is finished date of panel’s installation at project sites by customer, could raise resource constrain in test and commissioning stage. Since the resource planning has been done for distribution of test & commissioning engineers at concurrent running project of PSN business unit, any change in start date may impact on entire business unit progress. Gate and milestone deliverables have been presented in model overview.



Gate Model 1– Customer Gate & Milestone Overview

5. Analysis

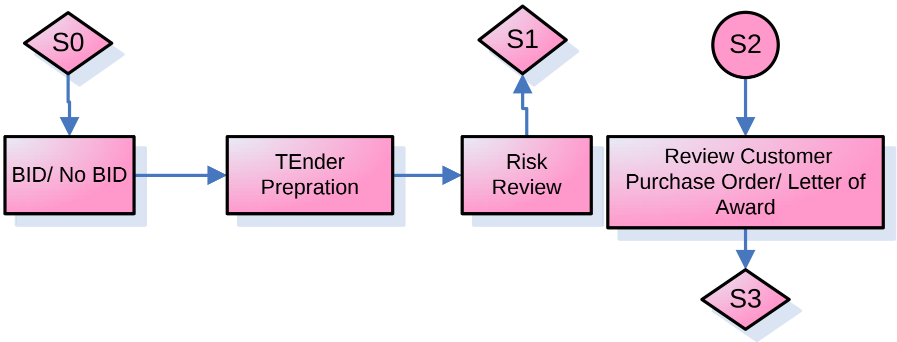
Gate model 2 presents the Engineering/ Design model over view of smart execution process model. The flow starts with E0 which is cost estimate of engineering/ design cost of project in terms of required man hours and design and so on, as input data for sales process and ends with E9 which is final engineering gate to release the “As Built Drawings”. The model overview also shows each gate input requirement and deliverables



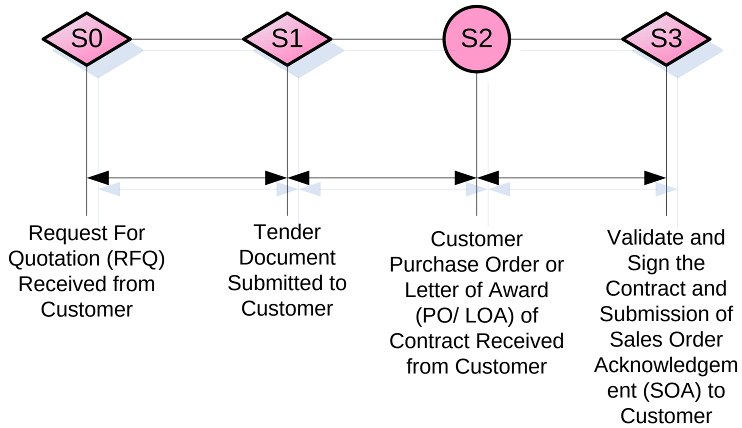
Gate Model 2– Design/ Engineering Gate Overview

5. Analysis

Gate model 3 presents the Sales Process Overview and Gate model 4 presents the sales gates overview of “Smart Execution” Process model with each gate required information and gate/ milestone deliverables. Sales gates start with S0 which PSN project start trigger (i.e. receiving the request for quotation) from Customer and ends with submission of order acknowledgement against received letter of award or purchase order from customer for any PSN project.

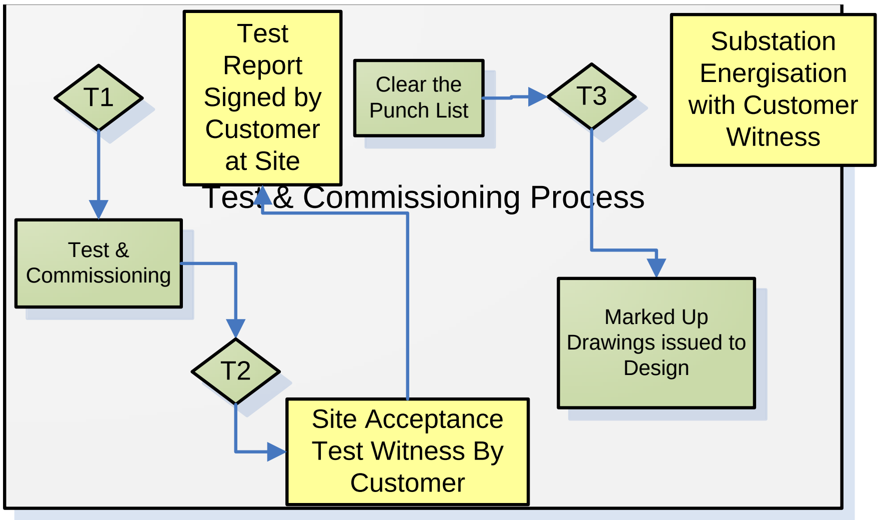


Gate Model 3– Sales Process Overview

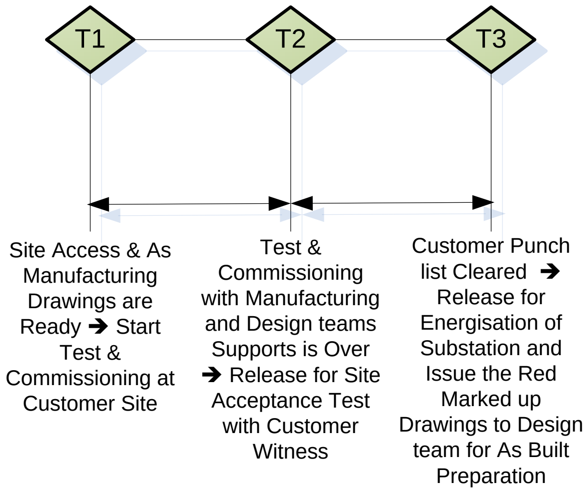


Gate Model 4– Sales Gate Overview

Gate model 5 presents the test & commissioning process overview and Gate model 6 presents the test & commissioning gates overview of “Smart Execution” Process model with each gate required information and gate deliverables. Test and commissioning process start with readiness of site access (i.e. panels’ installation and fit out at customer site finished by customer) and continues with site acceptance test with presence of customer witness and signing the test reports by same person. Then clearance of issued punch list by customer and energisation of entire substation. At the end the red marked up drawings will be sent to design team to prepare the "As built Drawings". During the test and commissioning activity technical supports in terms of any design changes/ complications and manufacturing supports in terms of requirement for implementation of any change orders by customer or rewiring of any material inside the panels will be provided by respective team (i.e. design team and manufacturing team)

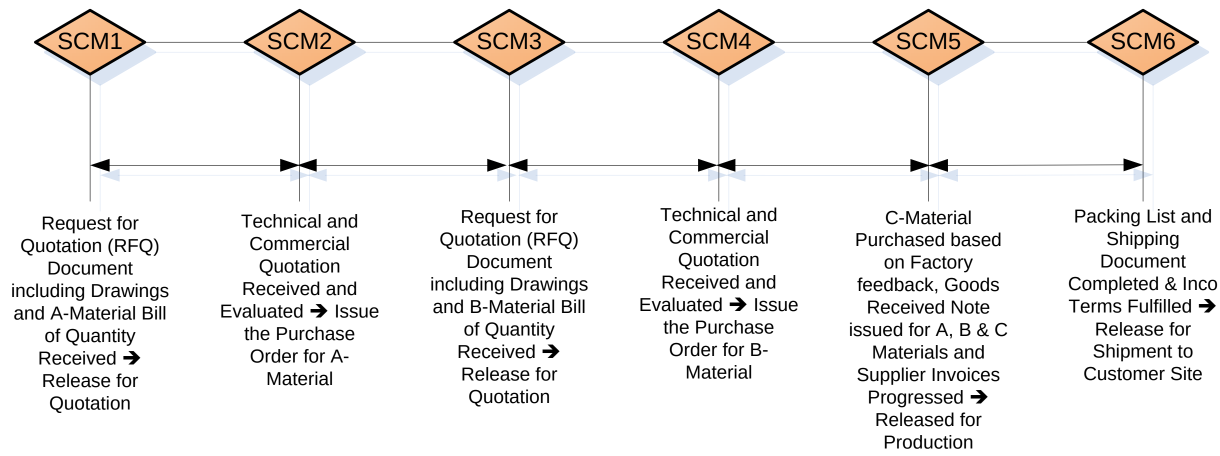


Gate Model 5– Test & Commissioning Process Overview



Gate Model 6– – Test & Commissioning Gate Overview

Gate model 7 presents the Supply chain management gates overview of "Smart Execution" Process model with each gate required information and gate deliverables. It starts with SCM1 which releases the RFQ document for A-Materials and SCM2 with issuance of purchase orders for A-Materials and SCM3 which releases the RFQ document for B-Materials and SCM4 with issuance of purchase orders for B-Materials. These for gates will be run with close cooperation of design team and supply chain management team as shown in Gate Model 11 as interrelated process overview. After delivery of A-Materials and B-Materials the cooperation between supply chain team and manufacturing team will be required in terms of quality and quantity check of delivered materials into ABB factory. C-Materials are all common materials which will be used in all PSN projects and are available in factory inventory. So, the inventory check for availability of C-Materials will be done by manufacturing team as well and in case of requirement for any C-Material, supply chain will place the order to respective supplier.



Gate Model 7– – Supply Chain Management Gate Overview

Then, Material classification should be developed in ABB-PSN factory as well. The material used for production of control and protection panels is categorized according delivery times and preference of use (standard/ non-standard)

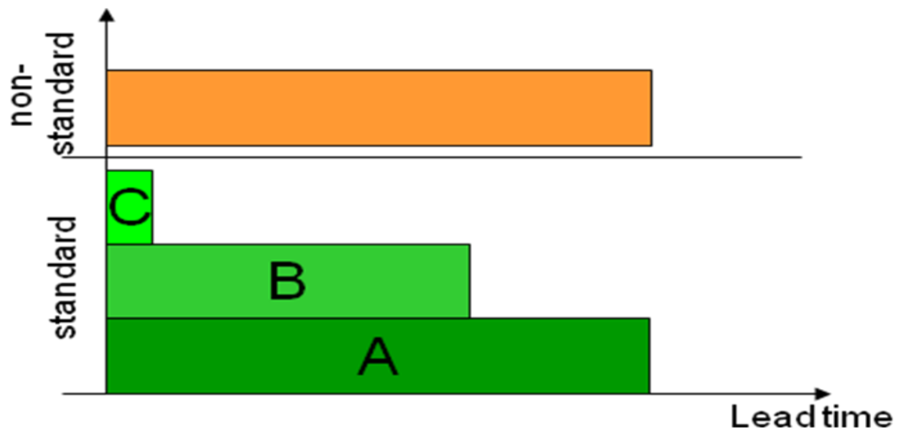


Fig12 – Material Classification Model

5. Analysis

Standard material is classified into three classes according their delivery lead time.

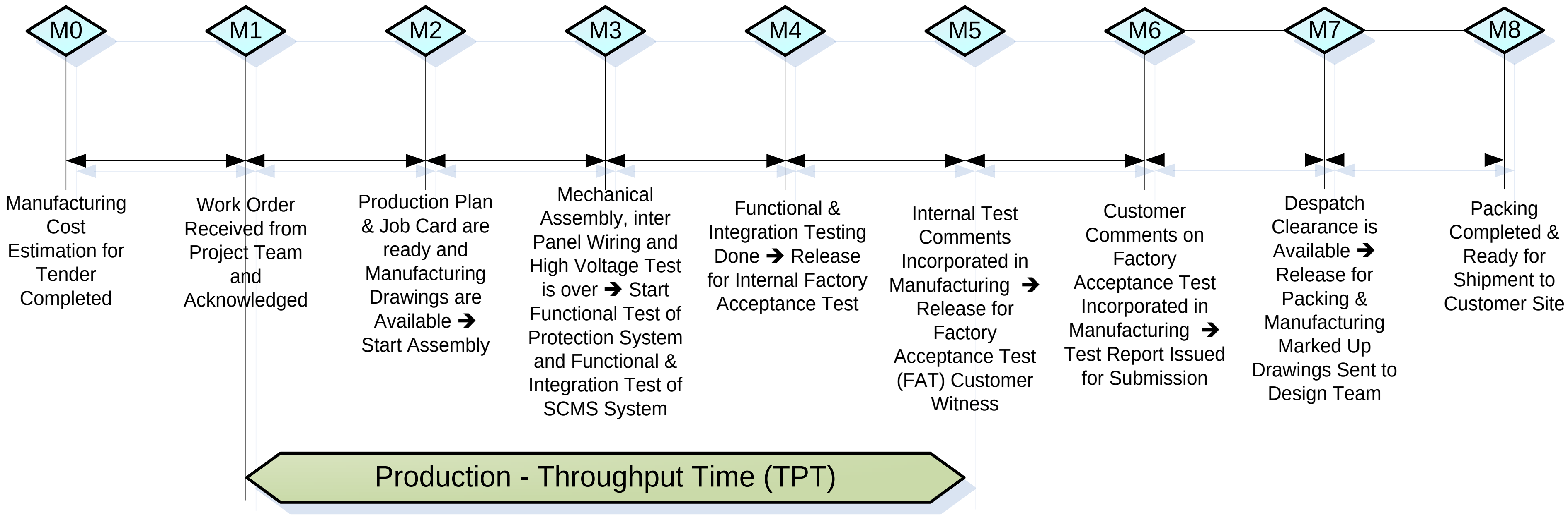
Delivery times of non-standard material shall be verified at an early stage when it is used for the first time in any PSN project.

Material Definition	Description
“A” Material	▪ Determinates the main functionality and parameters of the system and has long delivery time (more than 6 - 8 weeks) ▪ List of A material is created during base design ▪ A material is ordered project specific → E.g. IEDs, Combiflex relays and enclosures
“B” Material	▪ Always delivery time under 6 weeks ▪ Output from engineering, included in Bill Of Materials → E.g. Standard MCBs, Auxiliary relays
“C” Material	▪ Frequently used standard material, generally low value per item ▪ Material is kept on stock → E.g. Standard phoenix terminals and terminal accessories

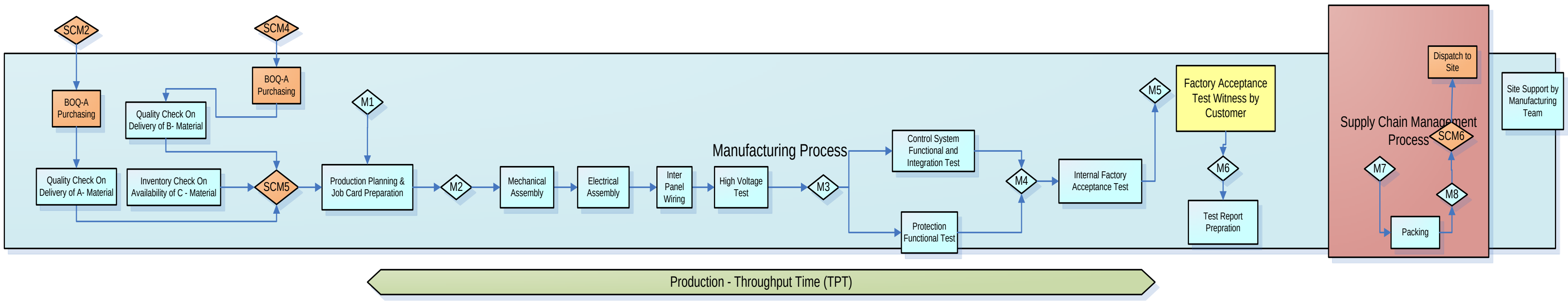
Table3 – A.B & C Materials Classification

Non-standard Materials also will be ordered project specific and the material delivery conditions shall be checked at sales stage (i.e. during the estimating the project cost). It will be non-standard material once is used for the first time by PSN business unit and then shall be regarded as A-Material until the delivery conditions become known.

5. Analysis



Gate Model 8– – Manufacturing Gate Overview

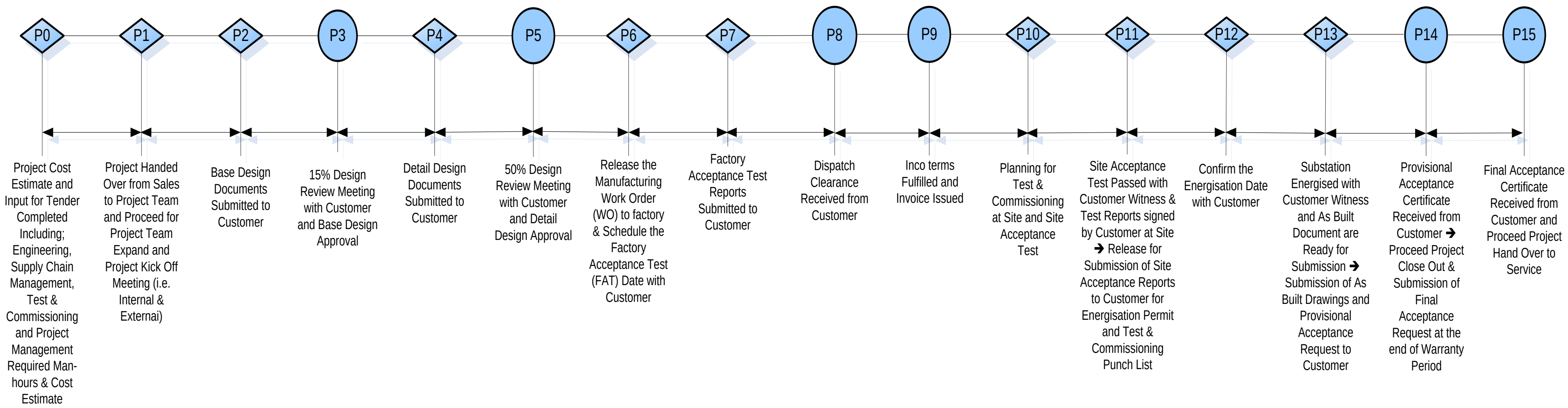


Gate Model 9– Manufacturing Process Overview

5. Analysis

Gate model 9 presents the manufacturing process overview and Gate model 8 presents the manufacturing gates overview of “Smart Execution” Process model with each gate required information and gate deliverables. The gate overview starts with M0 which is regarding the providing of manufacturing cost estimation information in terms of required resources (i.e. tangible and intangible resources) as lesson learned from previous projects and ends with M8 gate which is defined for making decision about releasing the manufactured, tested and packed panels for shipment to customer/ project site. As already mentioned earlier in this section, ABB-PSN famous KPI which is TPT (i.e. throughput time) starts M1 gate (i.e. receiving of manufacturing work order from project management team) and ends with M5 gate (i.e. completion of internal factory acceptance testing) which is defined for making decision for release for factory acceptance test with customer witness presence.

Table4 & Gate model10 presents the Project Management Gates & Milestones overview of “Smart Execution” Process model with each gate required information and gate deliverables.

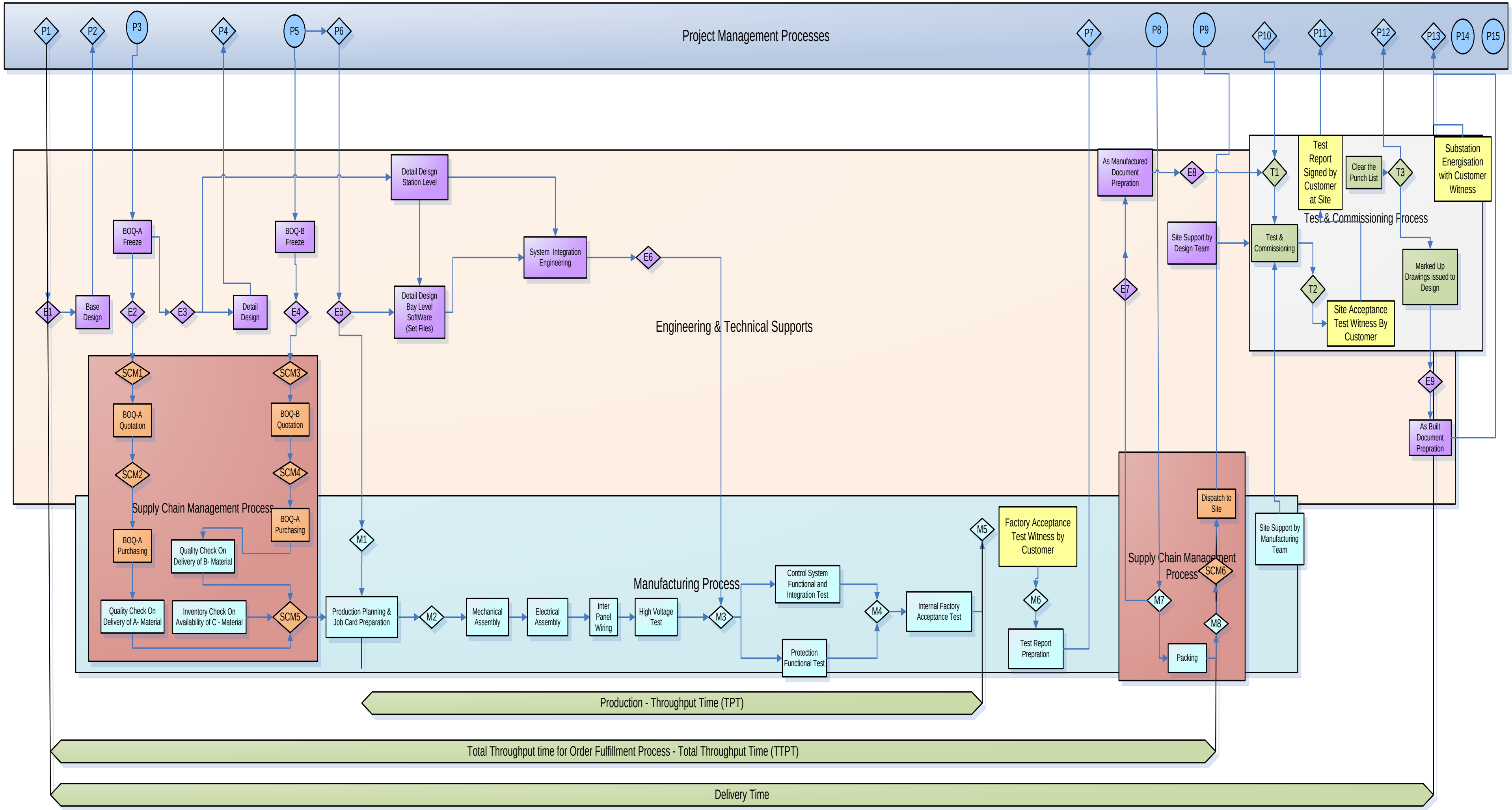


Gate Model 10– Project Management Gate & Milestone Overview

Item	Gate/ Milestone	Gate/ Milestone Objectives and Deliverables
1	P0	Project Cost Estimate and Input for Tender Completed Including; Engineering, Supply Chain Management, Test & Commissioning and Project Management Required Man-hours & Cost Estimate
2	P1	Project Handed Over from Sales to Project Team and Proceed for Project Team Expand and Project Kick Off Meeting (i.e. Internal & External)
3	P2	Base Design Documents Submitted to Customer
4	P3	15% Design Review Meeting with Customer and Base Design Approval
5	P4	Detail Design Documents Submitted to Customer
6	P5	50% Design Review Meeting with Customer and Detail Design Approval
7	P6	Release the Manufacturing Work Order (WO) to factory & Schedule the Factory Acceptance Test (FAT) Date with Customer
8	P7	Factory Acceptance Test Reports Submitted to Customer

9	P8	Dispatch Clearance Received from Customer
10	P9	Inco terms Fulfilled and Invoice Issued
11	P10	Planning for Test & Commissioning at Site and Site Acceptance Test
12	P11	Site Acceptance Test Passed with Customer Witness & Test Reports signed by Customer at Site ➔ Release for Submission of Site Acceptance Reports to Customer for Energisation Permit and Test & Commissioning Punch List
13	P12	Confirm the Energisation Date with Customer
14	P13	Substation Energised with Customer Witness and As Built Document are Ready for Submission ➔ Submission of As Built Drawings and Provisional Acceptance Request to Customer
15	P14	Provisional Acceptance Certificate Received from Customer ➔ Proceed Project Close Out & Submission of Final Acceptance Request at the end of Warranty Period
16	P15	Final Acceptance Certificate Received from Customer and Proceed Project Hand Over to Service

Table4 – Project Management gates & Milestones Overview



Gate Model 11– – Interrelated Process Overview

5. Analysis

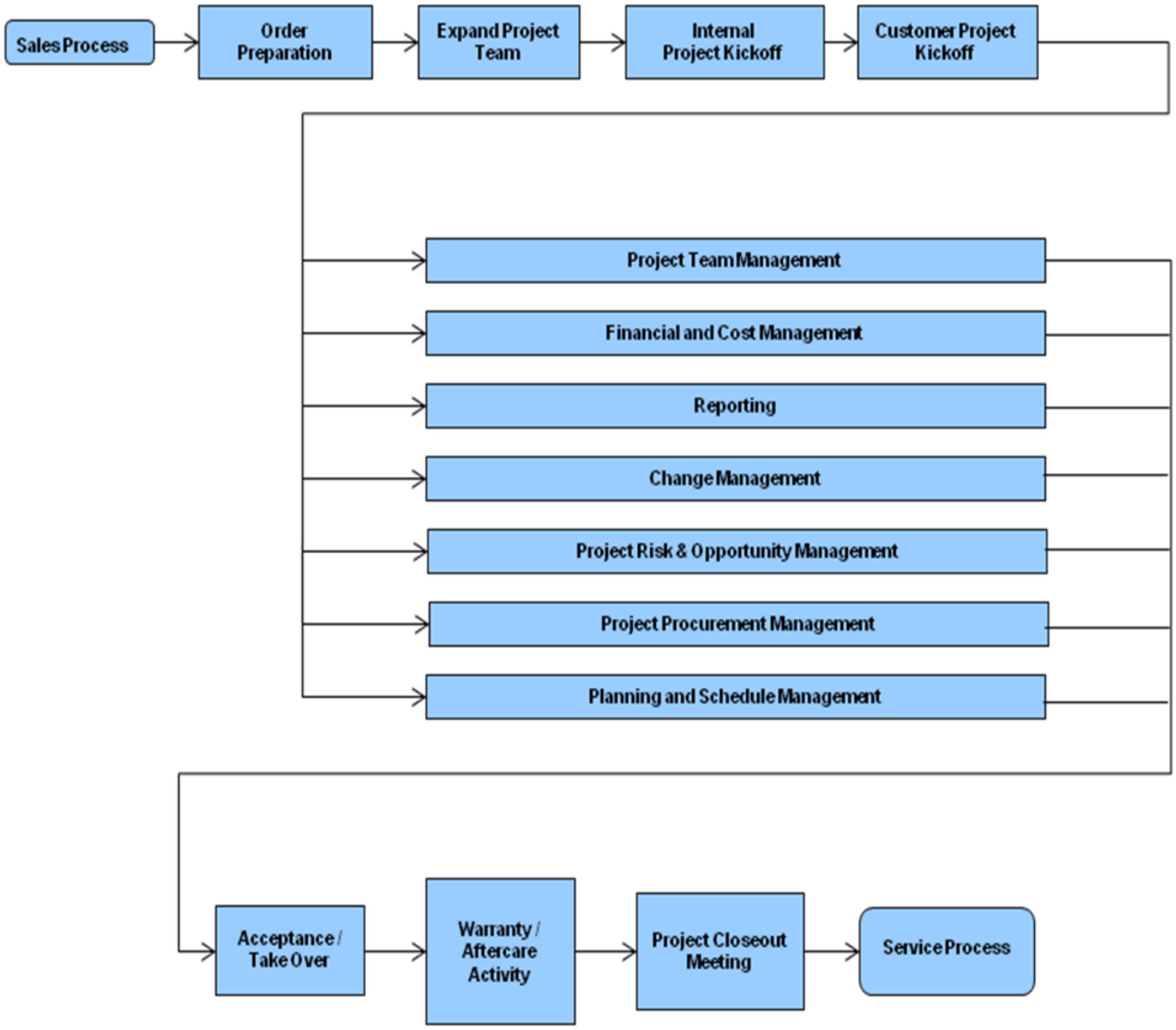
Gate model11 presents the interrelation processes among project management process, engineering, supply chain management, manufacturing and test & commissioning processes. As it shown in the gate model 11, supply chain management team will process the supply chain management activities in close cooperation with manufacturing team and design team. Another part of model which is related to test and commissioning activity requires close cooperation among test & commissioning team, design team and manufacturing team. Of course, the core of all cooperation belongs to project management team. So, the gate meeting participants in each gate meeting depends on project status. Certainly, in project internal kick off meeting, the project team from different functional units will be present and roles and responsibilities will be clearly defined. And then invitation for each gate meeting will be sent out by project manager. And based on project status project functional team member will be mandatory or optional.

5.4.2. Redesigned Management Processes:

According to newly developed gate model with set of rules for processing the project execution at ABB-PSN business unit and results of analysis of existing processes new set of management processes redesigned and defined. The new sets of processes are shown in coming pages.

1- Developed Project Management Processes:

Process 7 shows the project management process over view which includes 15 sub-processes to cover all project management activities during the project execution. In fact, process1 replaced by Process7.



Process 7 – Project Management Process Overview

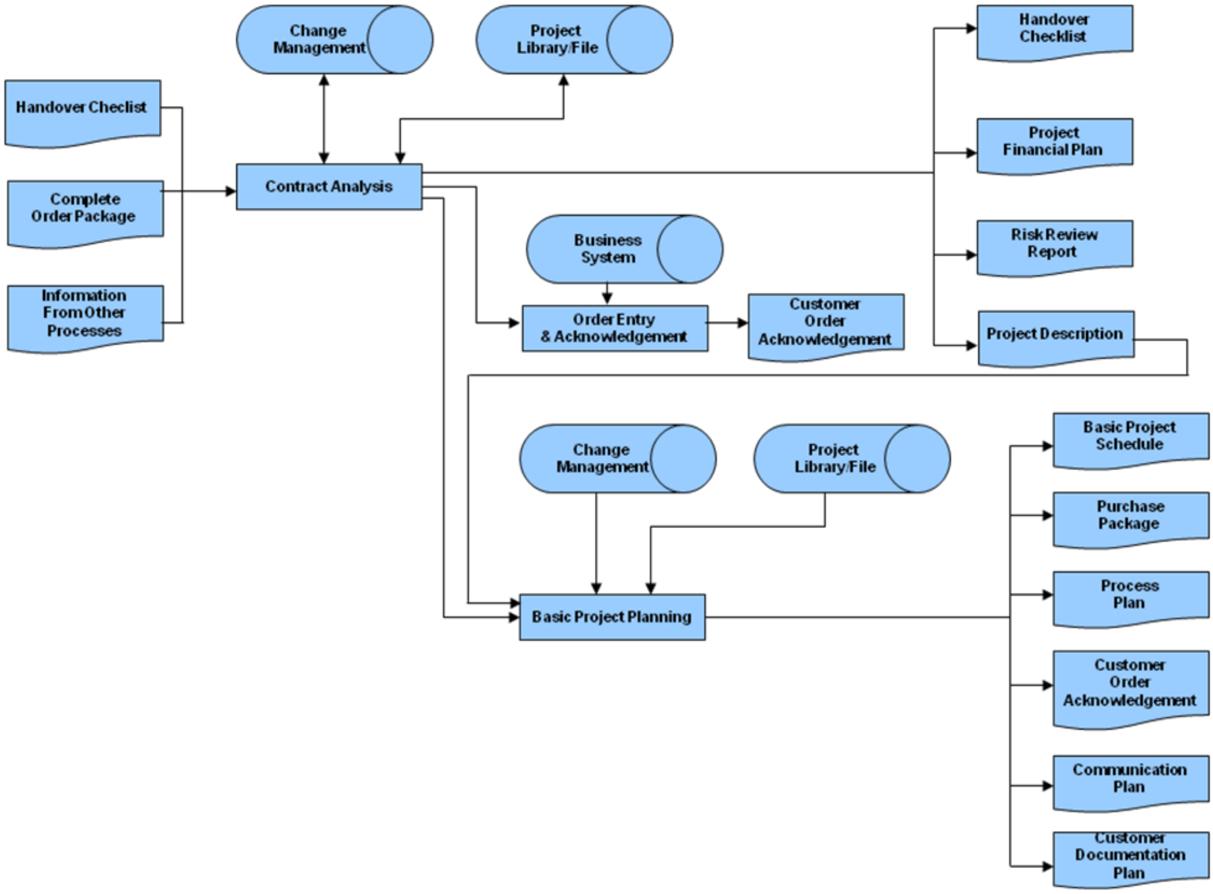
5. Analysis

1.1. The first step is order preparation process according to process8 and the objective of that step is to verify/ establish the baseline for the project enabling a predictable Project Execution and Complete administrative tasks necessary to start up the project and to plan the execution of the project.

Process Description - The Sales process has been completed and the order received from the Customer. The Project Manager moves from the role as a member of the Cross Functional Team to the active role of project management, taking accountability and ownership of the project.

Contract Analysis - The PM assumes the responsibility for the contract. If there is any doubt whether all contractual aspects including; Terms and Conditions, Schedule and Cost, as well as technical matters reviewed during the Cross Functional Team activities are acceptable, this must be verified now. The result of this activity is PM’s final acceptance of the contract and sign-off of the project financial plan. Project summary information is compiled in a Project Description. The intention with this analysis is to verify that all elements required for predictable and successful project execution have been/are covered.

Order entry and acknowledgement - The order is entered into the business system (i.e. Enterprise Resource Planning (ERP) system), by order administration as instructed by the Project Manager. Cost report line items and milestones are set up. The order acknowledgment is generated and sent to the Customer. An Order Acknowledgment, based on PM’s input as part of the order entry documents, is generated by order administration.

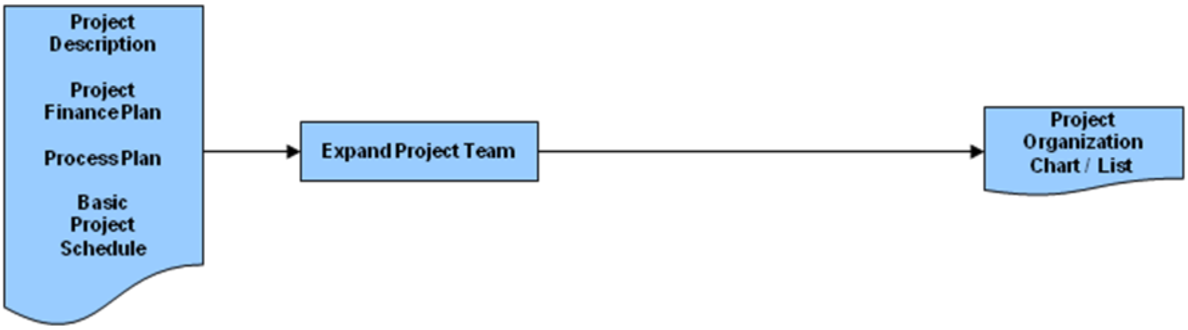


Process 8 – Order Preparation Process Overview

Develop a Basic Project Schedule, a Process Plan, a Communication Plan, a Customer Documentation Plan, and define the Project Filing system. Through this activity the project scope activities, including customer obligations, are planned and/or refined. Details such as Work Breakdown Structure (WBS) are developed and/or refined in the Planning and Schedule Management activity.

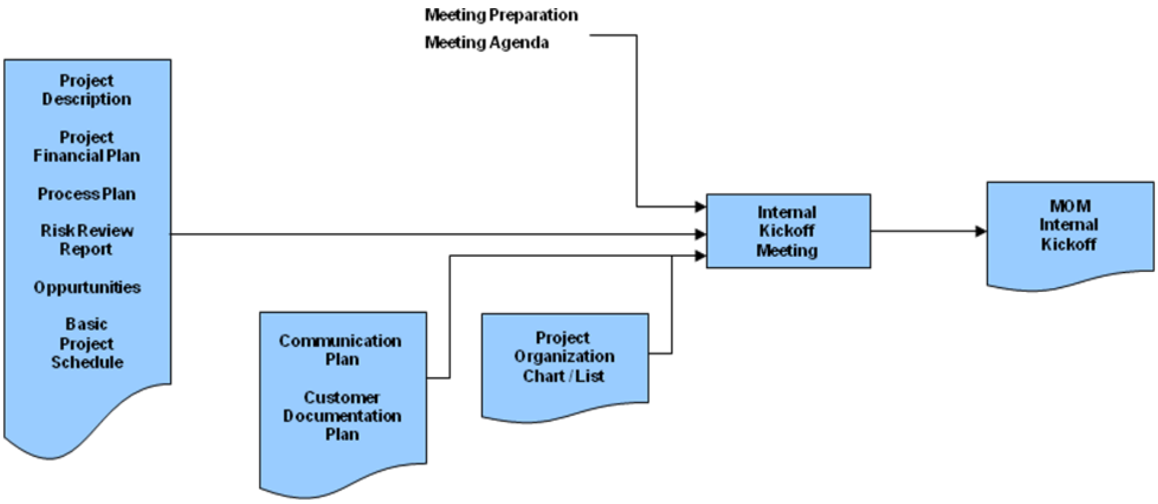
The Process Plan is the document used to define how the process applies to a specific project, i.e. if a certain process activity is not applicable, or apply only to a limited degree, this is to be documented. Filled out Process Plan has to be signed off by Management, as locally defined.

1.2. Second step is expanding the project team as shown in process 9. The objective of this step is to Expand the Project Team with resources required to successfully execute the project. This is done by the PM in conjunction with functional managers. Based on the Basic Project Schedule, the skill mix and skill levels necessary to execute all project activities are determined, and the project team members are selected. Team members project specific roles and responsibilities are defined.



Process 9 – Team Expand Process Overview

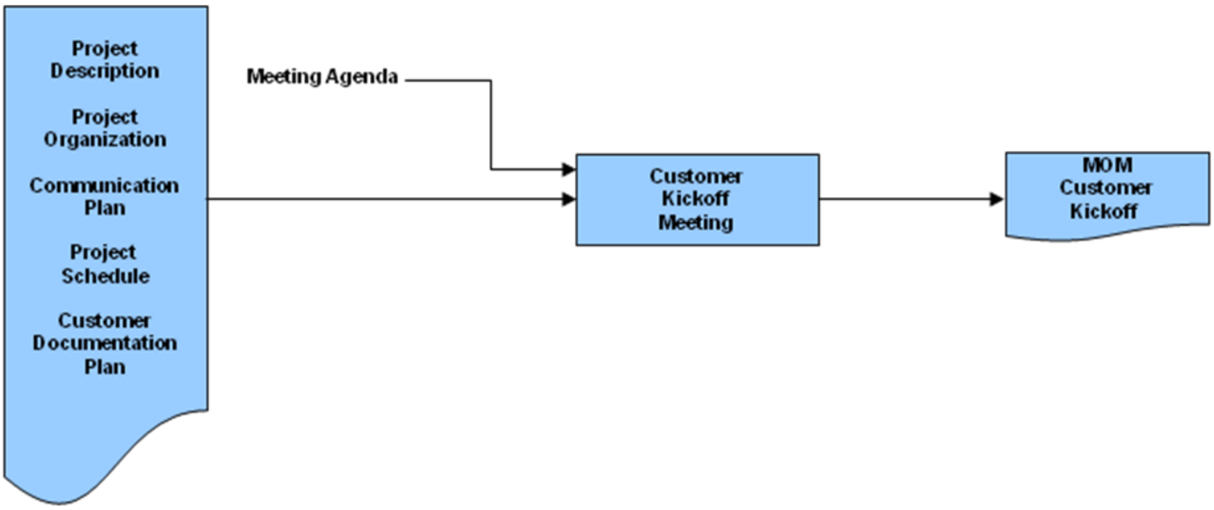
1.3. Third step is Internal Kick off meeting and the objective of this step is Kicking off the project and achieves internal commitment for resources and project schedule as shown in Process10. An Internal Kickoff Meeting is prepared, organized, called and conducted by the PM. The project team members are informed of project scope and; financial plan, project organization, communication plan, process plan, project schedule, and customer documentation plan. The meeting involves, as a minimum, sales and the project team. If applicable, the management of Engineering, Manufacturing, Supply & Demand Chain Management, and Project Management should be involved. Meetings could be conducted in person, as videoconference, or by telephone.



Process 10 – Internal Kick off meeting Process Overview

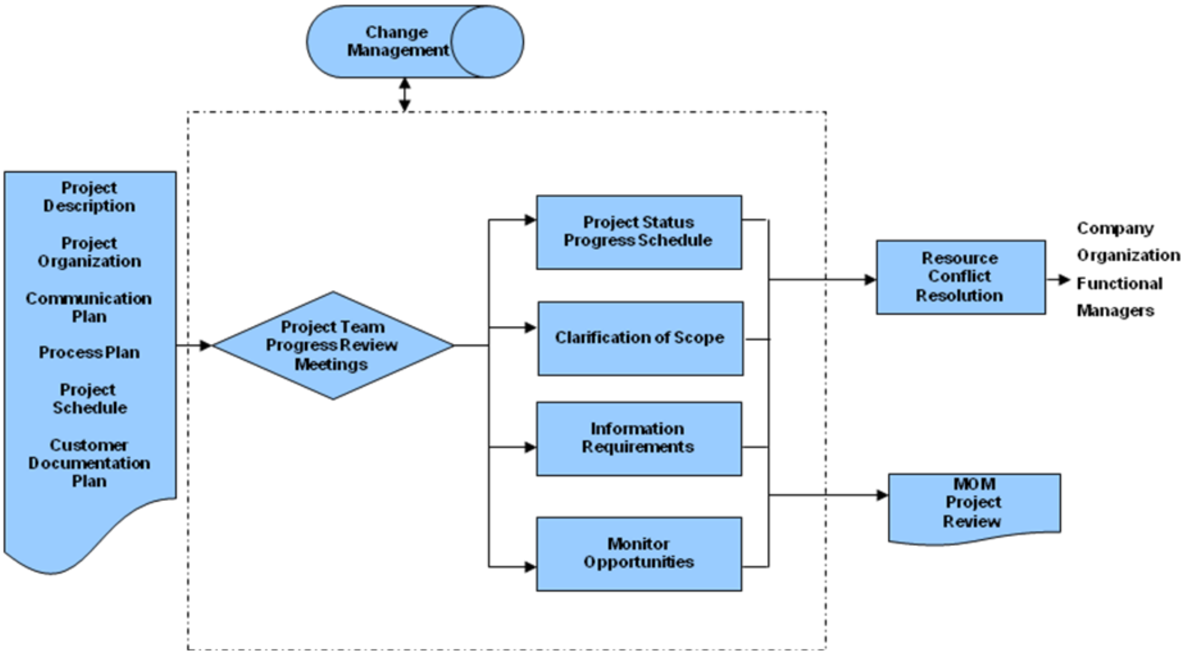
1.4. The next step as shown in Process 11 is Customer kick off meeting process which Ensure that all parties have a common understanding of the scope of supply and the detailed requirements of the project, including project organization, project basic schedule and how the project will be executed.

A Customer kickoff meeting is prepared, organized, called and conducted by the PM. The meeting involves the Customer's project team and ABB-PSN participants selected by the PM. For some projects additional kickoff meetings with third parties may be required. Meetings could be conducted in person, as videoconference, or by telephone.



Process 11 – Customer Kick off meeting Process Overview

1.5. The next step is Project Team Management as shown in Process12 and the objective of this step is Manage and coach a Project Team assembled from cross-functional representatives throughout all project phases. Success of a project team requires clearly defined Roles and Responsibilities for all team members. Each team member must take accountability for the assigned activities. The PM should hold regular gate reviews with the project team. This is an important part of the PM's managing of the project team, keeping informed of project issues and to ensure that all team members have the information necessary to perform the assigned project tasks and making right decisions at right time.

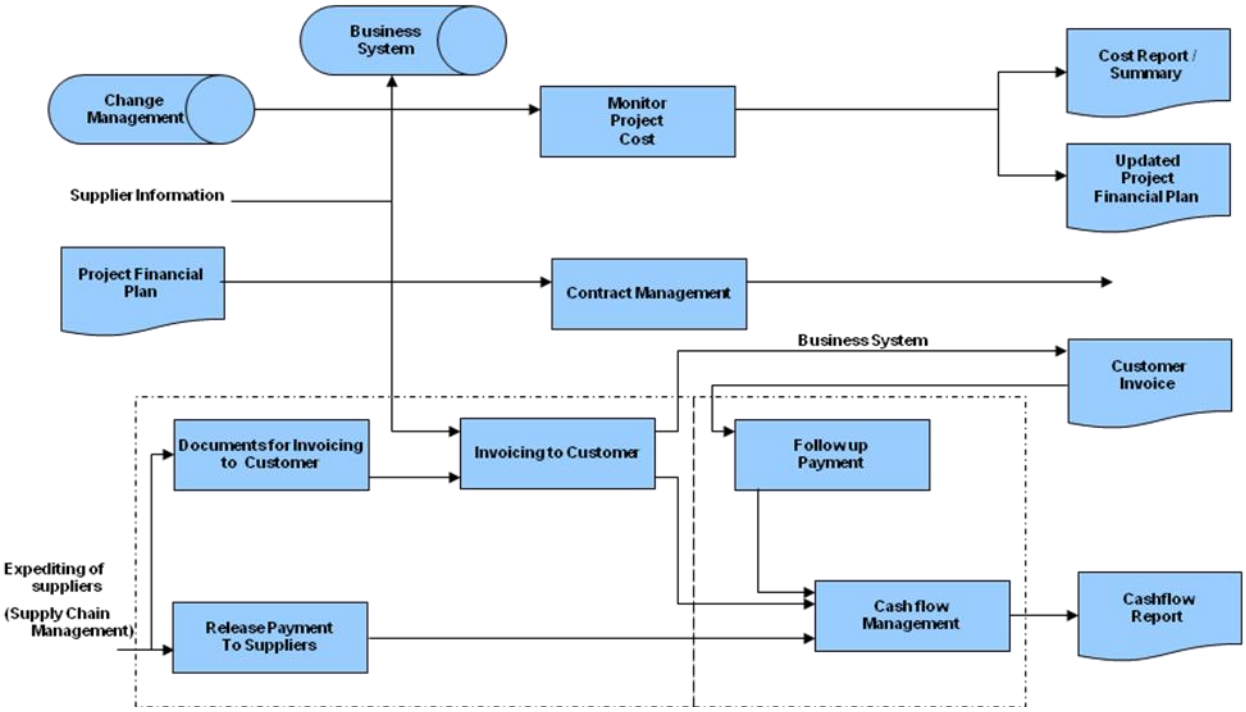


Process 12 – Project Team Management Process Overview

1.6. The next step is project financial management which has been shown in process13. The objective of that step is to Monitor and control project financials. ABB expects the PM to maintain or improve the contract margin. Cost control within the project scope, and management of the financial aspects of the project, including cashflow management are high priority activities throughout the project cycle.

PM can monitor project costs and cost to complete against anticipated expenditures. Review actual cost as charged, and/or committed to, in the company's business system. Update "estimated" and "planned" cost, as applicable. Cashflow management involves timely Customer invoicing and follow up in order to achieve prompt payment. An invoice is generated through PM's release of the associated milestone in the company's PSN business system.

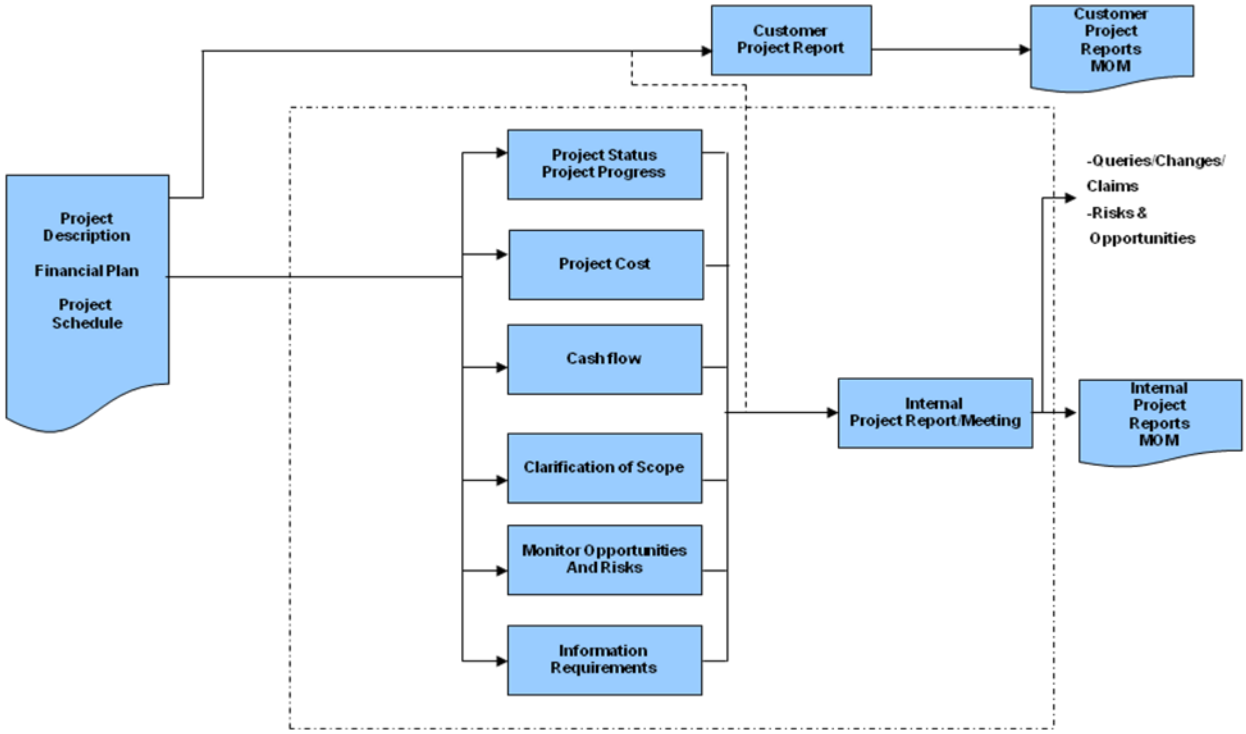
In addition, Bank Guaranties, Performance Bonds, and Letter of Credits are often used to secure a money transaction, contingent on a specified performance, between a Customer and a vendor. These can be highly specialized for specific contract conditions. Thus support from legal and/or finance department, as well as external banking institutions is often required. It is the responsibility of the PM as contract manger of respective project, to be fully aware of the contract requirements and coordinate the necessary support from any function required, in order to obtain, manage, and close any and all of the documents required.



Process 13 – Project Financial Management Process Overview

1.7. The other step is Project Reporting which has been shown in process14. The objective of that step is to Convey appropriate project information to customer and other project stakeholders. Timely and accurate reports are required to keep Customers and management updated with the status of the project. Project specific information is periodically communicated to Customer, management, and others as required.

In addition, Regular project review meetings should be held by management and/or finance. The PM should participate in these meetings and report the status of current projects, based on information from planning and schedule management, cost and financial management, etc. and as required by Management. Meetings could be conducted in person, as videoconference, or by telephone.



Process 14 – Project Reporting Process Overview

1.8. One of the most sub-processes in project management process is change management process which has been shown in process15. The objective of this sub-process is to Collect and manage all project issues, whether just a question or a change, with associated negotiations and approvals.

The Change Management process is the means by which technical issues, or issues with financial or schedule impact, are raised, and managed. This includes Queries, Changes and Claims. Project related Faults and Non Conformances are documented through the same process.

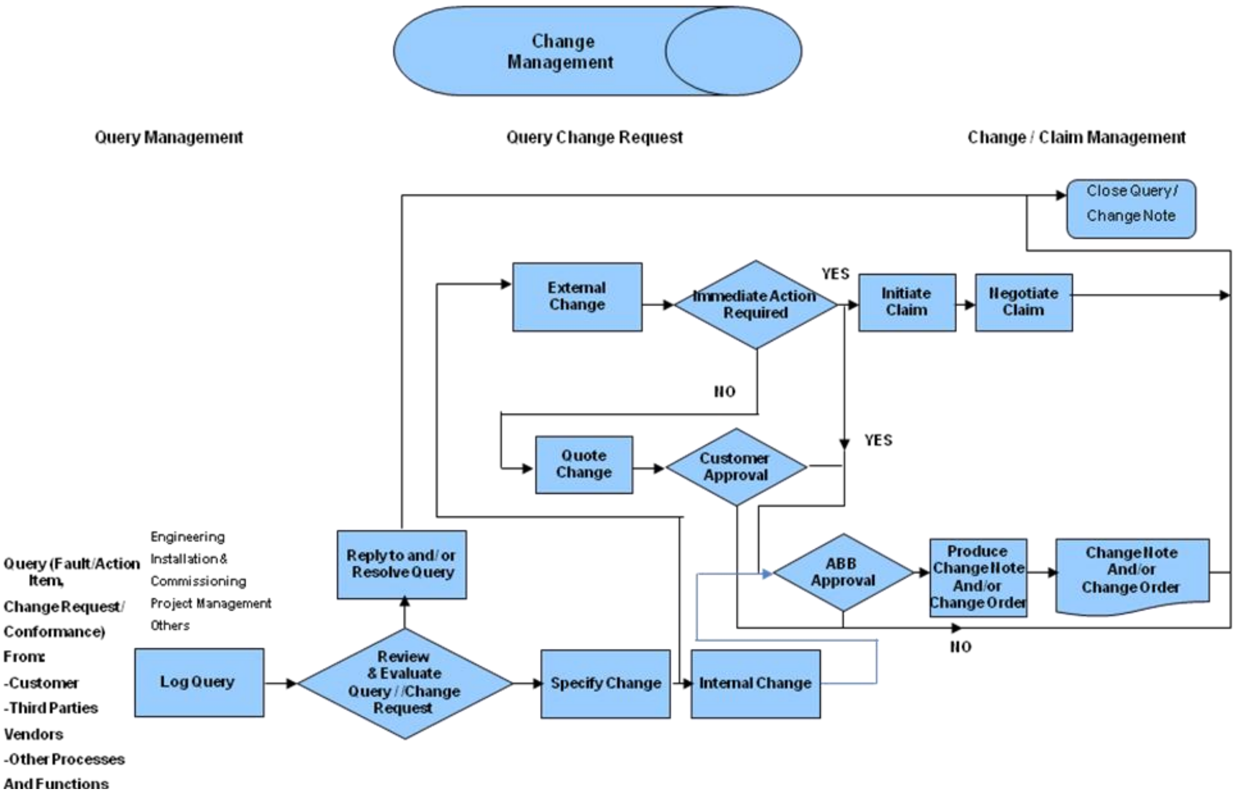
It is the responsibility of everyone involved in a project to identify and log queries as they arise. A query with no cost, scope, or schedule impact may be immediately answered/re-solved and closed. Queries with cost and/or schedule impact, or that requires a more comprehensive review, are directed to the appropriate function for further action. A query may initiate a project change and/or claim. A Query that also is a Customer dissatisfaction issue is addressed also through the Customer Complaint Resolution Process (CCRP).

Requests for changes to the project scope of supply, schedule and financial issues, whether generated externally or internally, must be managed so that any potential impact can be properly assessed. To properly document a fault/action item, a possible change and/or claim it is first always logged as a Query. The resulting changes can then be integrated into the work-in-progress with minimum impact to cost and schedule. A Change Note is generated to order and document every change.

A Claim is the result of a change asked for or required but not yet confirmed in a change order to the contract.

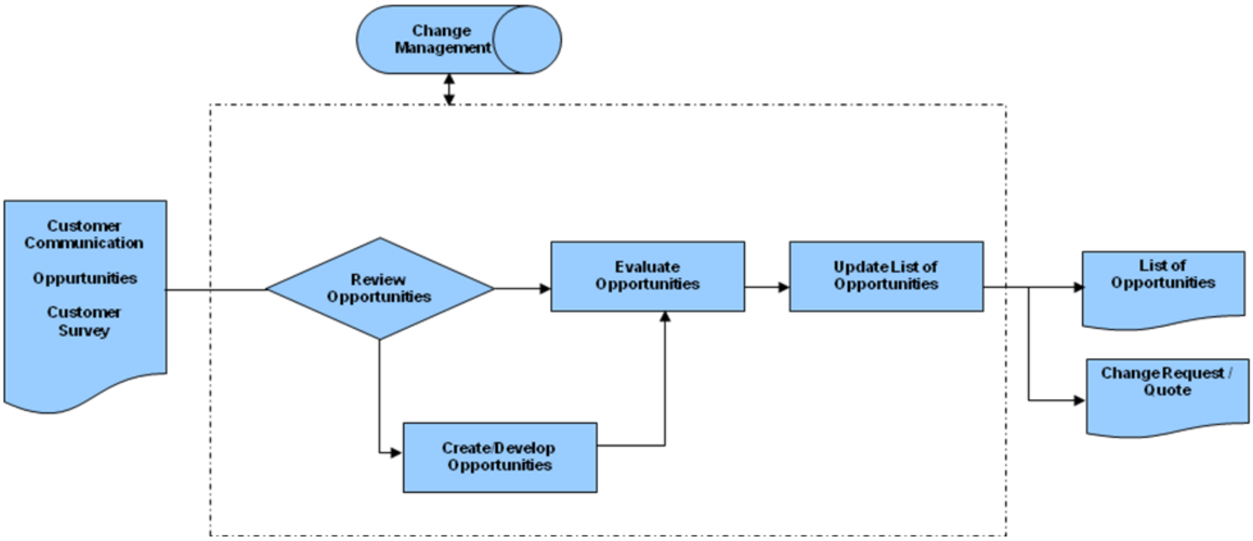
Changes which are expected to be paid for by others, i.e. Customer or other party, should only exceptionally be proceeded with, without first reaching an agreement. When a change that should be paid by someone else is necessary to proceed with, but an agreement confirming this is not yet obtained it becomes a claim. A claim can be made to the Customer, to a vendor or to any contractor or third party involved.

The Project Manager acts to avoid/minimize claims towards ABB. Claims that cannot be avoided, needs to be managed professionally in order to minimize impact to cost and schedule.

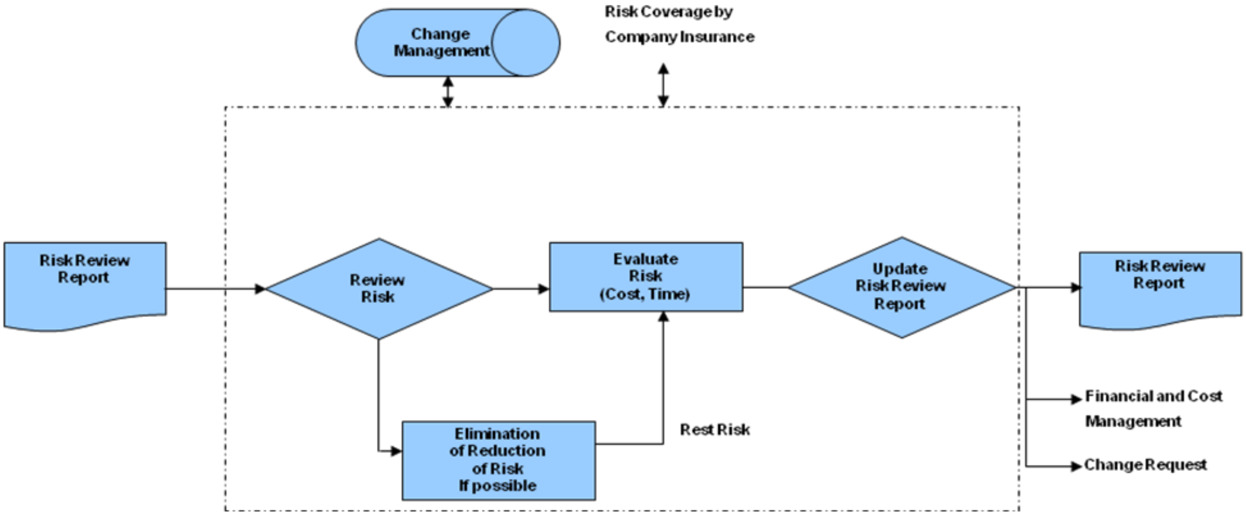


Process 15 – Change Management Process Overview

1.9. The next important sub-processes are project Risk & Opportunity Management processes which has been shown in process 16 & 17. Opportunity management sub-process ensures that all opportunities for Customer Satisfaction, Gross Margin Improvement and/or Project Growth are captured. And project risk management sub-process Contain and reduce the risk exposure identified within the Sales process, during Contract Analysis or later.



Process 16 – Opportunity Management Process Overview



Process 17 – Risk Management Process Overview

A PSN project typically involves numerous contacts with the customer. With the length of time project managers and the project team deal with customers there are great opportunities to learn more about what the customer needs are, and what's really important for the particular customer. Throughout the project, the Project Manager acts to create and/or capture opportunities for additional sales. A successfully executed project often includes additional sales by the PM and it also sets the ground for repeat business. So, PM monitors the processes to ensure that opportunities are captured and that unforeseen risks are avoided.

1.10. Another important sub-process is project procurement management process which has been shown in process18 and the objective of that sub-process is to obtain necessary services, materials and equipment from external and internal suppliers. This sub-process includes all activities from the first project related contact with the suppliers until completed delivery, acceptance, warranty and payment. This process is heavily integrated with the Supply Chain Management processes (i.e. process6 which already discussed earlier in Q2 section). This sub-process covers the interfaces between supply chain management process and project management process. So, the Supply Chain Processes are to be followed for all Project Procurement.

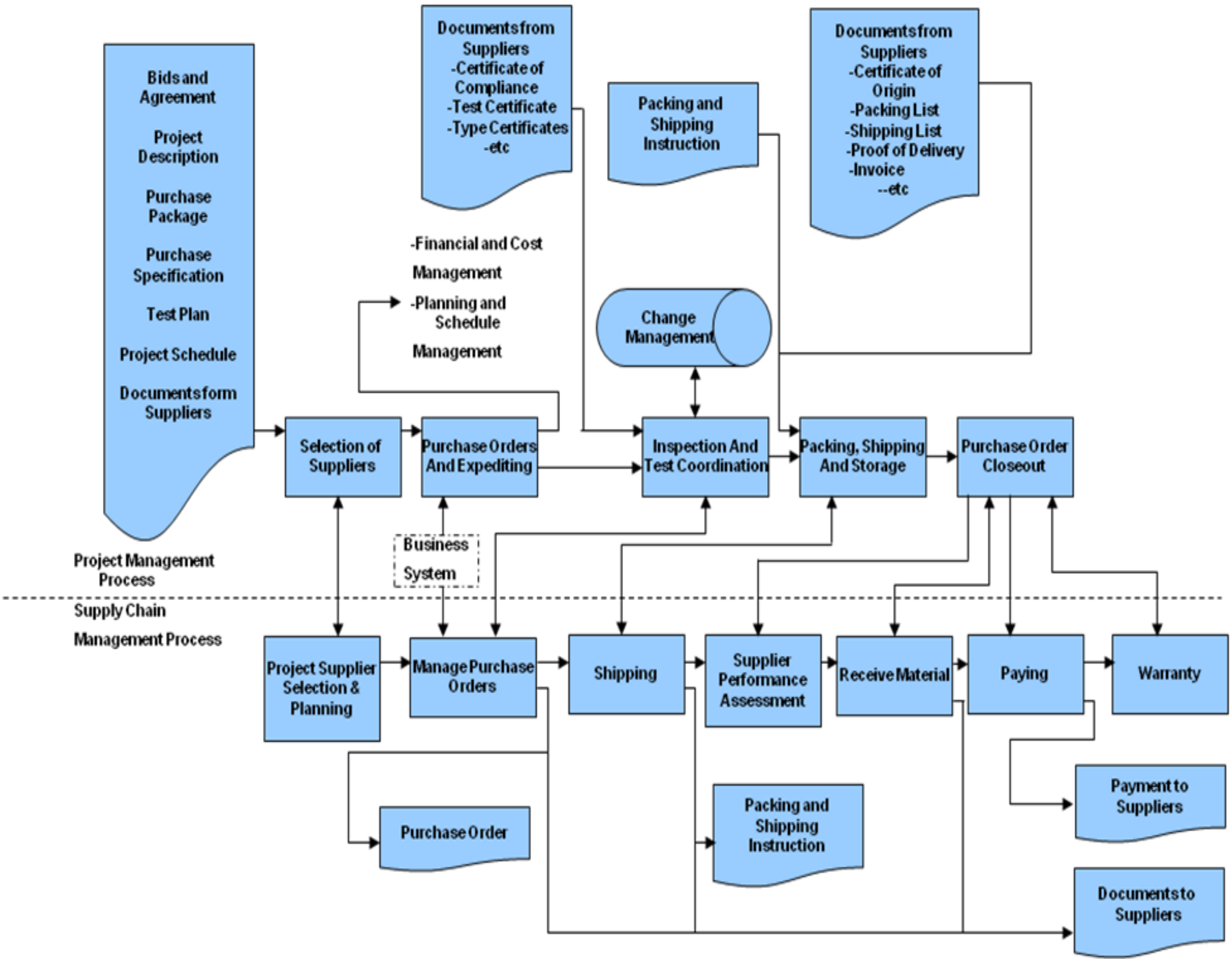
Selection of suppliers is done in cooperation between Project Management and Supply Chain Management, based on, customer requirements, list of qualified suppliers, previous deliveries, technical specifications, quality level and commercial aspects. Before selection of a supplier, all aspects (technical, timeliness, completeness, value of bid, supplier capability, risk, etc.) should be validated. An early Supply Chain Management involvement is important for sourcing and negotiation of the best possible purchase agreement

The PM authorizes purchase orders for all "buyout" project purchases. Supply Chain Management issues Purchase Orders based on PM's purchase requisition and/or Engineering's purchase specification.

Purchase Orders are followed-up to ensure that delivery commitments will be met and in accordance with project requirements. If there is any indication that these commitments are not going to be met, then expediting, and if necessary escalation must take place. This includes the supply of technical and commercial documents, software and hardware items, and services, included in the purchase order, in the specified time frame.

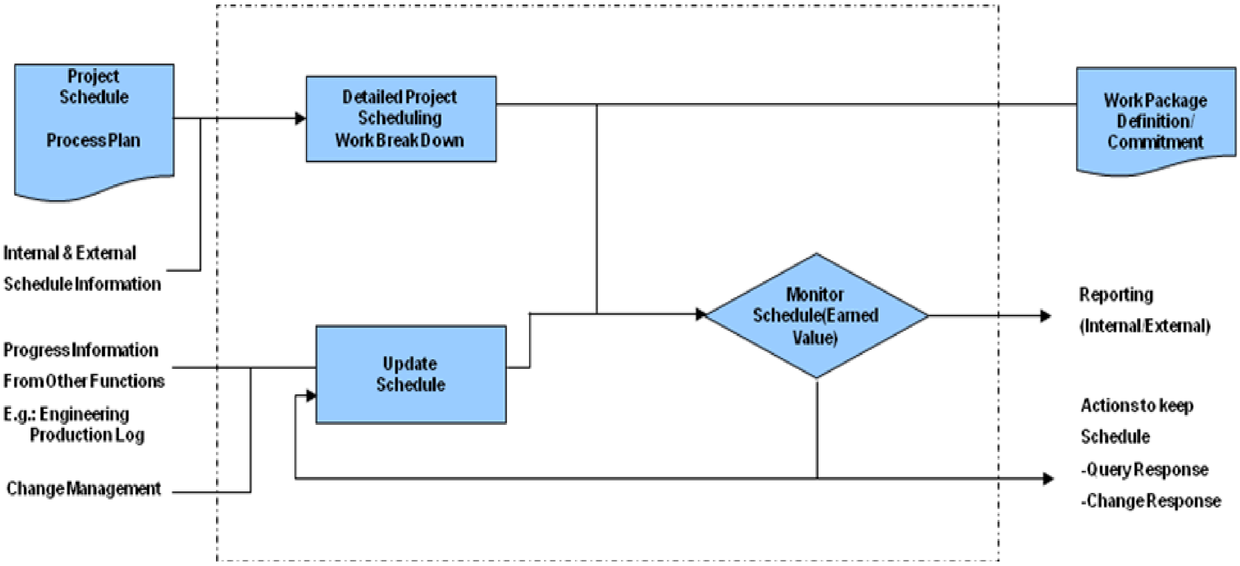
Upon receipt of the purchased service, material or equipment, and before approval of payment, the PM verifies that all committed to items are included, and on time. To ensure accurate tracking of delivery performance and smooth payment of suppliers, receipt of goods is promptly recorded in the business system.

At the time of purchase order closeout, Supply Chain Management will from time to time and for selected suppliers, provides a Supplier Performance Record to be filled out by the PM. The Supply & Demand Chain Management function includes supplier warranty management.



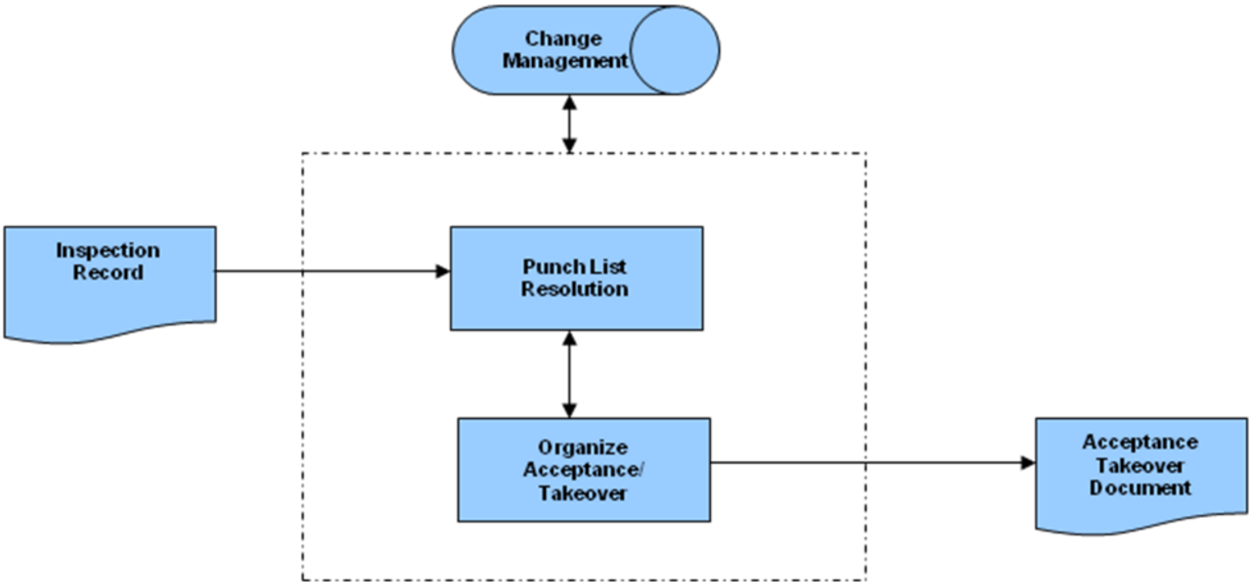
Process 18 – Project Procurement Management Process Overview

1.11. Another sub-process is Planning and Schedule Management process to Plan, schedule, and monitor project activities as shown in process19. This activity entails project planning (Scope Management) and scheduling of activities necessary for the project and with the efficient utilization of available resources. Develop a Project Schedule identifying specific activities to be performed during the course of the project. Identifies task dependencies and the critical path for the project. The detailed Project Schedule forms the basis by which the Project Manager and Lead Engineer will measure the progress. The PM addresses any need for changes in project resources from the line organization, with functional management.



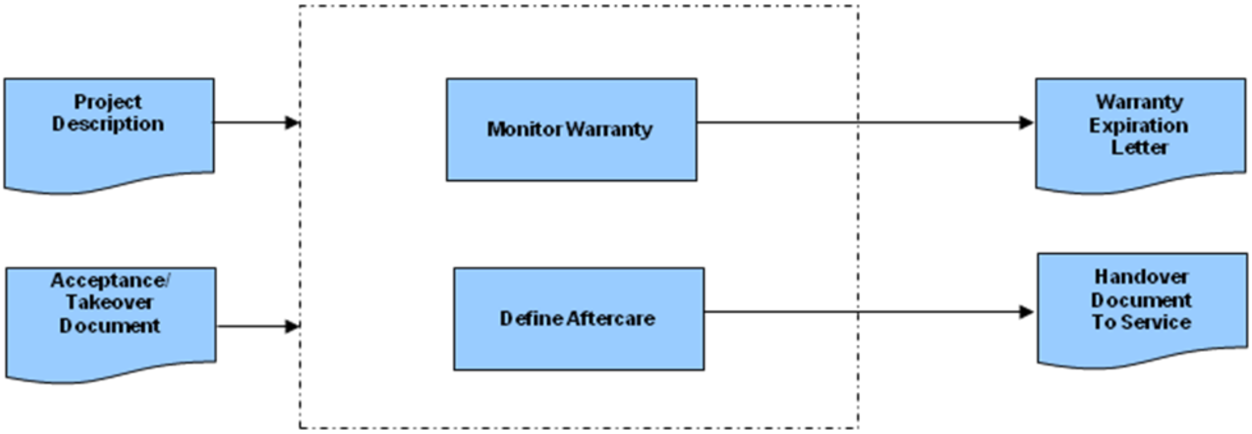
Process 19 – Project Planning and scheduling Management Process Overview

1.12. Next sub-process will be Acceptance/ takeover of the project as shown in proces20 to get the timely contract acceptances (i.e. Provisional Acceptance or Final Acceptance Certificates), final payment and takeover the project by the customer. Acceptance of a contract constitutes that a supplier has fulfilled its contractual obligations and commitments, including applicable performance bonds and guaranties, to respective Customer. Acceptance is initiated by ABB. An early acceptance is important but not necessary to the Customer. It is essential that all acceptance criteria be clearly defined, the acceptance is typically tied to significant payment and defines the conclusion of the warranty period.



Process 20 – Acceptance/ takeover Process Overview

1.13. Next sub-process will be Warranty of the project as shown in proces21 to Ensure that appropriate Warranty and Aftercare is provided to ABB's customers and Handover the project to Service division for long term service requirements. Warranty scope and duration is based on contractual agreement. Warranty expiration date is typically defined by the ship and/or energisation of substation date. Warranty start and end date has to be clearly defined and agreed with the Customer. Aftercare is the responsibility of others (local organization, ABB Service, etc.) who need appropriate information in order to perform their work.

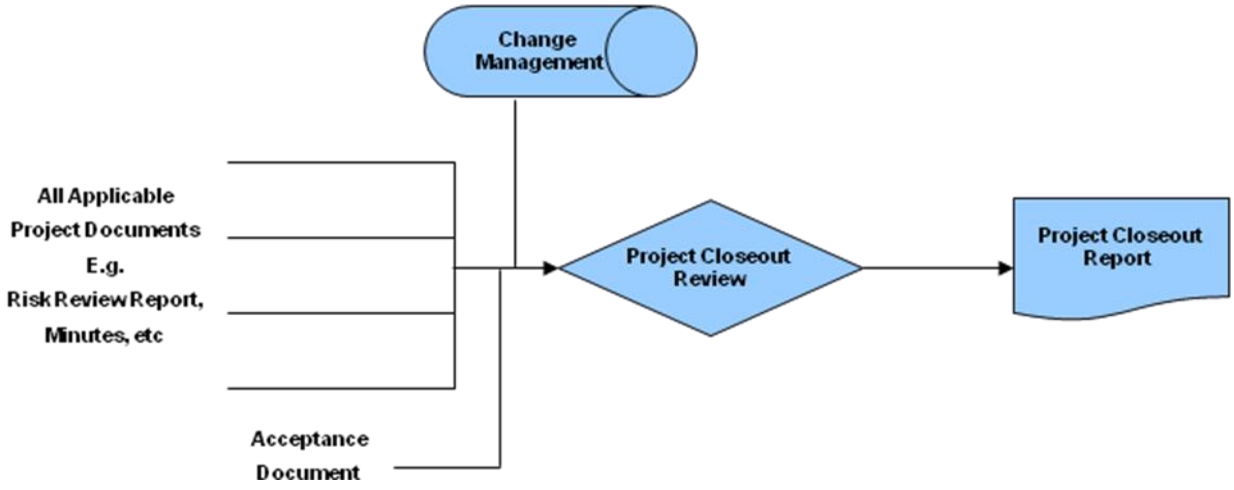


Process 21 – Warranty Process Overview

1.14. The last Step/ sub-process will be project close out as shown in proces22. to Assess the effectiveness of the process and report the findings to the process owner to facilitate further improvements (i.e. developing the lessons learned).

5. Analysis

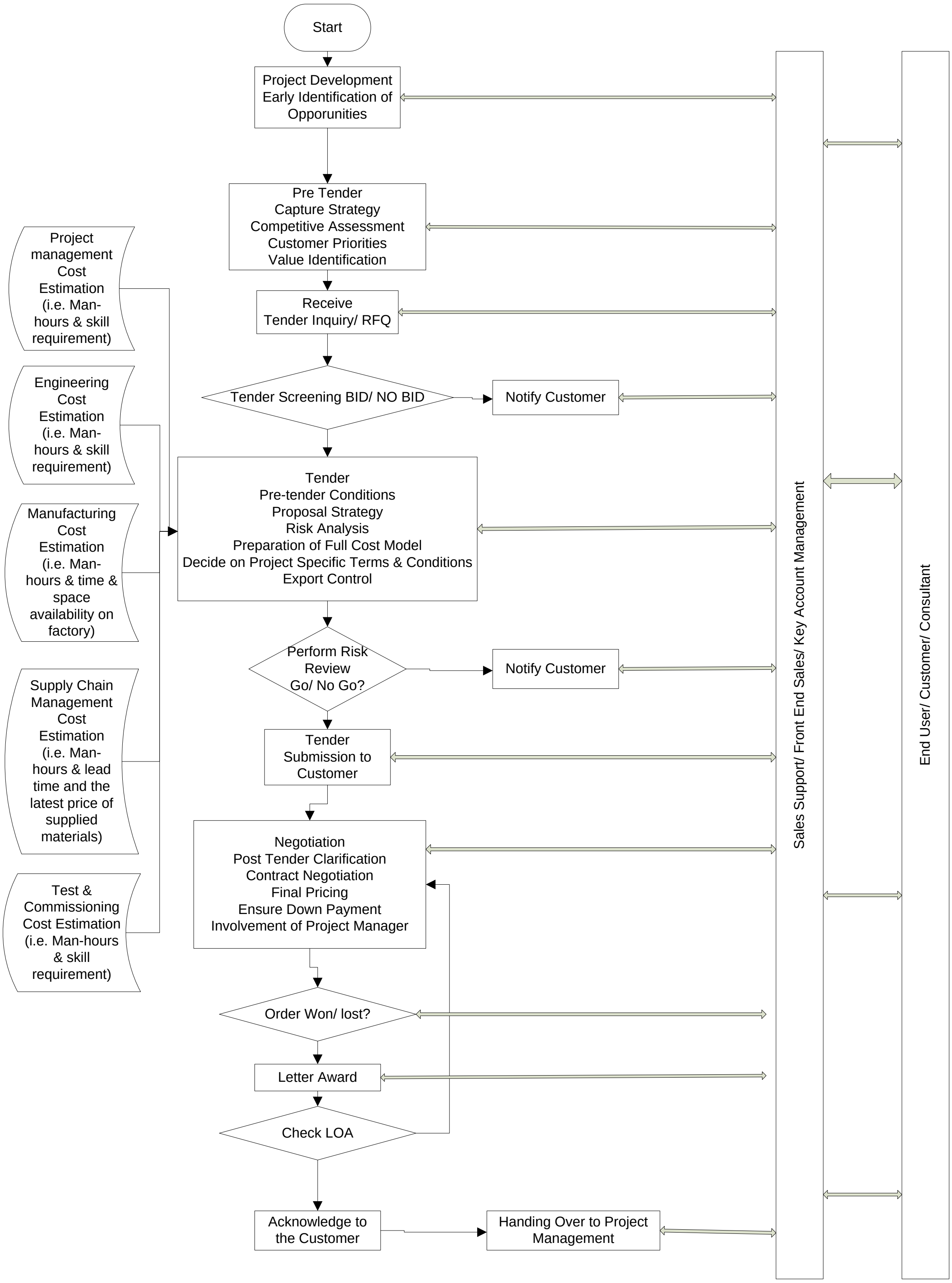
A project closeout meeting is prepared, organized, called and conducted by the PM, upon completion of a project. The meeting involves, as a minimum, sales and the project team, plus management of PM, Engineering, Manufacturing, and Supply Chain management, as applicable. The meeting minutes should document project successes and things to improve. Meetings could be conducted in person, as videoconference, or by telephone



Process 22 – Project Close out Process Overview

2- Developed Sales Process:

As already mentioned in Q2 section and process2, the major missing processes in Sales processes was related to getting the right information (i.e. cost estimation of finished goods, delivery times of already supplied materials for previous projects and man-hour & skill requirements based on lesson learned from previous projects or historical data from different functional units) and early involvement of project manager in negotiation stage with customer which has been developed in process23.



Process 23 – Developed Sales Process Overview

3- Developed Engineering Processes:

As already mentioned in Q2 section and process4 & process3, the major missing processes in engineering processes was related to interface process to sales process and site & manufacturing process. In fact the engineering processes which are related to support the other functional processes. So, the new set of processes developed as below (i.e. Process24, 25 & 26) to cover those requirements as well.

4- Developed Supply Chain Management Process:

As already mentioned in Q2 section and process6, the major weakness of Supply Chain Management process was related to interface process to project management and manufacturing process. The interface process with project management has already covered in procurement management sub-process (i.e. process18) and the other part developed and shown as process 27 – developed purchasing process and process28 – developed shipping process.

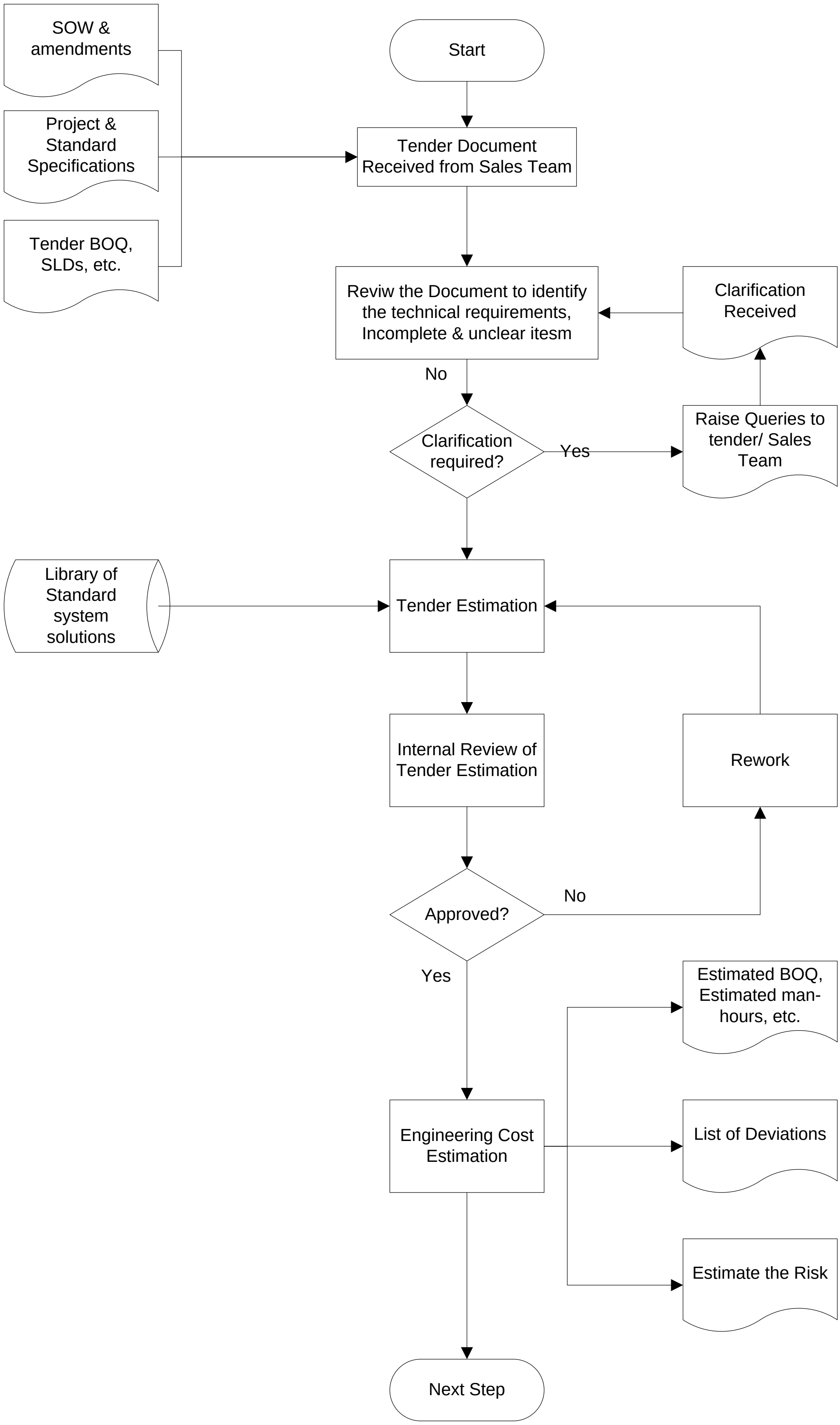
5- Development Assembly & Testing (i.e. manufacturing) Process:

Process29 presents the new developed manufacturing process and replaced with Process5.

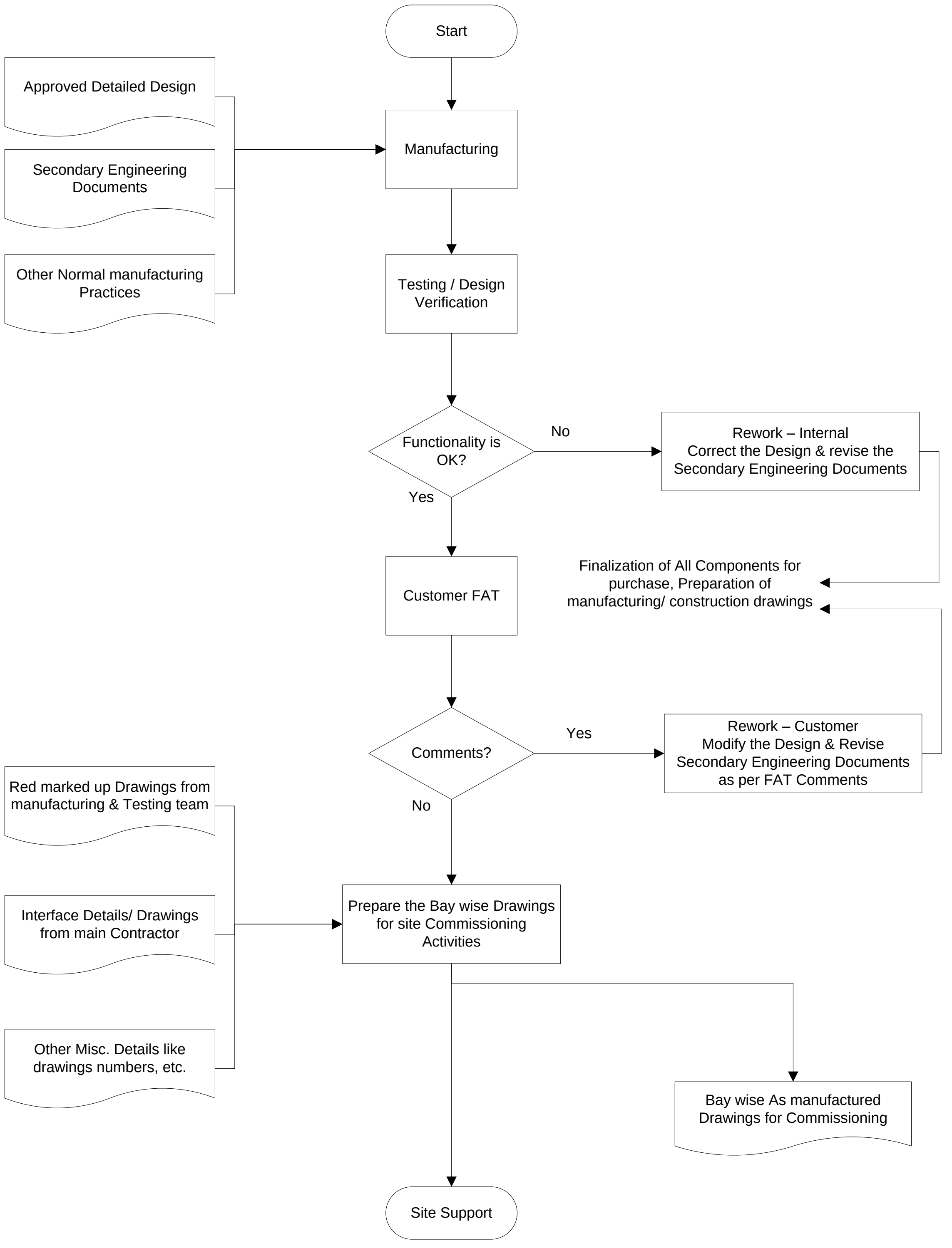
6- Development Test & Commissioning Process:

Since there was not any existing process regarding the test & commissioning functioning in PSN business unit. Process30 developed to cover business requirement.

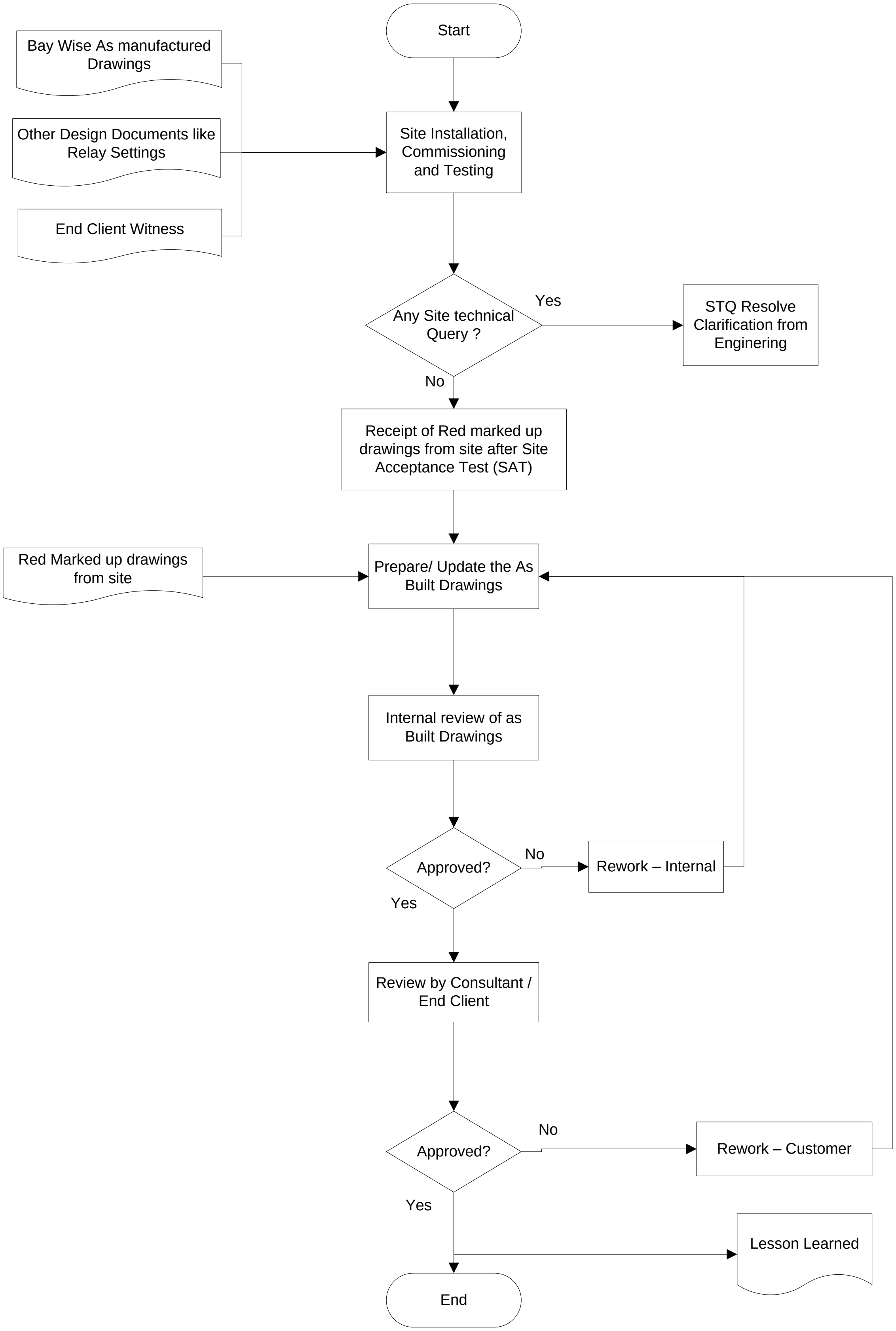
5. Analysis



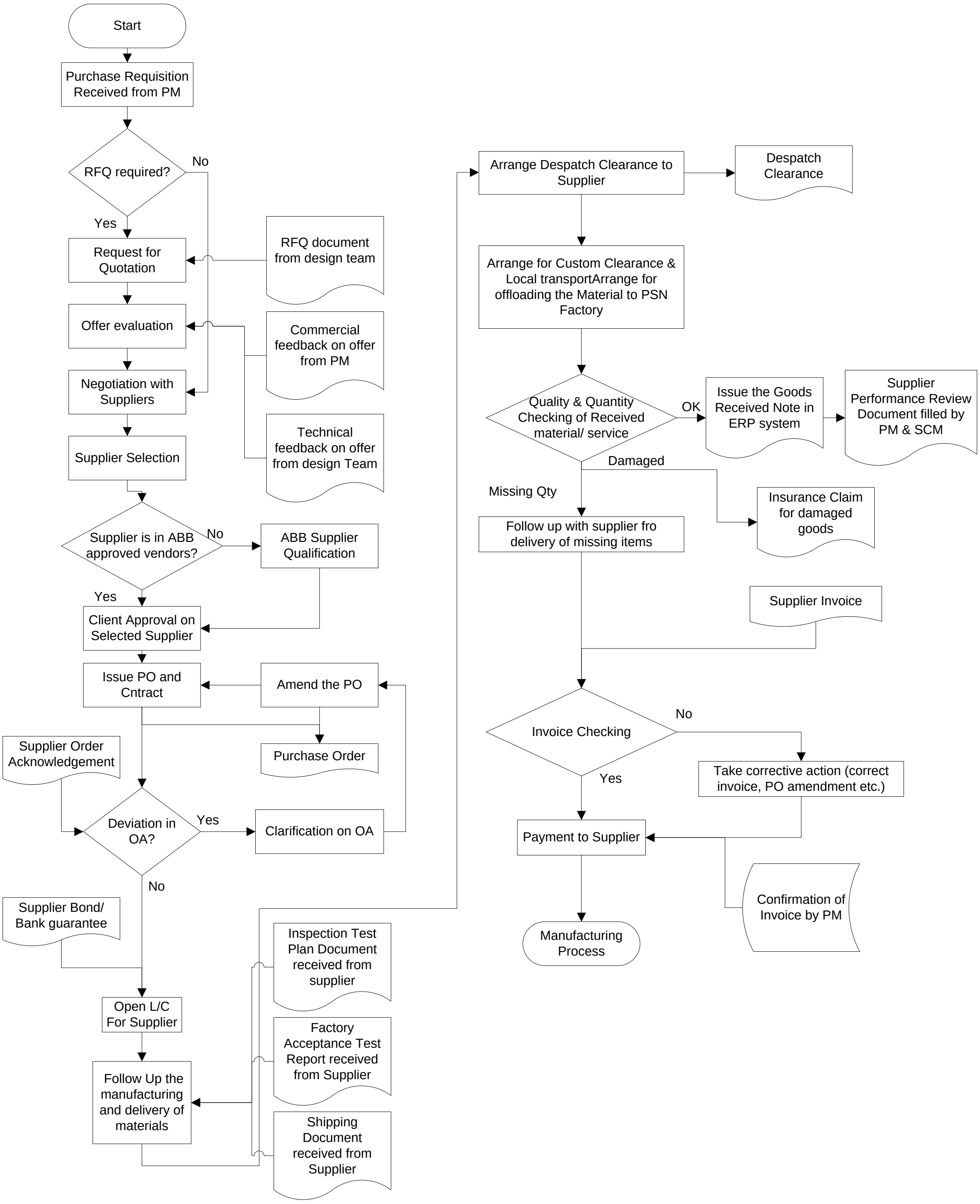
Process 24 – Tender Estimation Engineering Process Overview



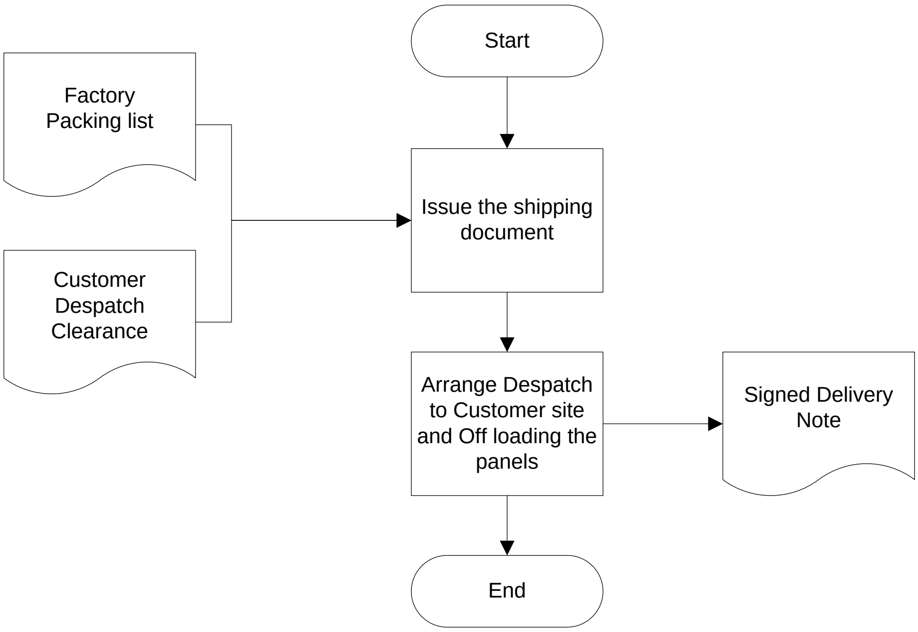
Process 25 – Manufacturing Support Engineering Process Overview



Process 26 – Site Support & As Built preparation Engineering Process Overview

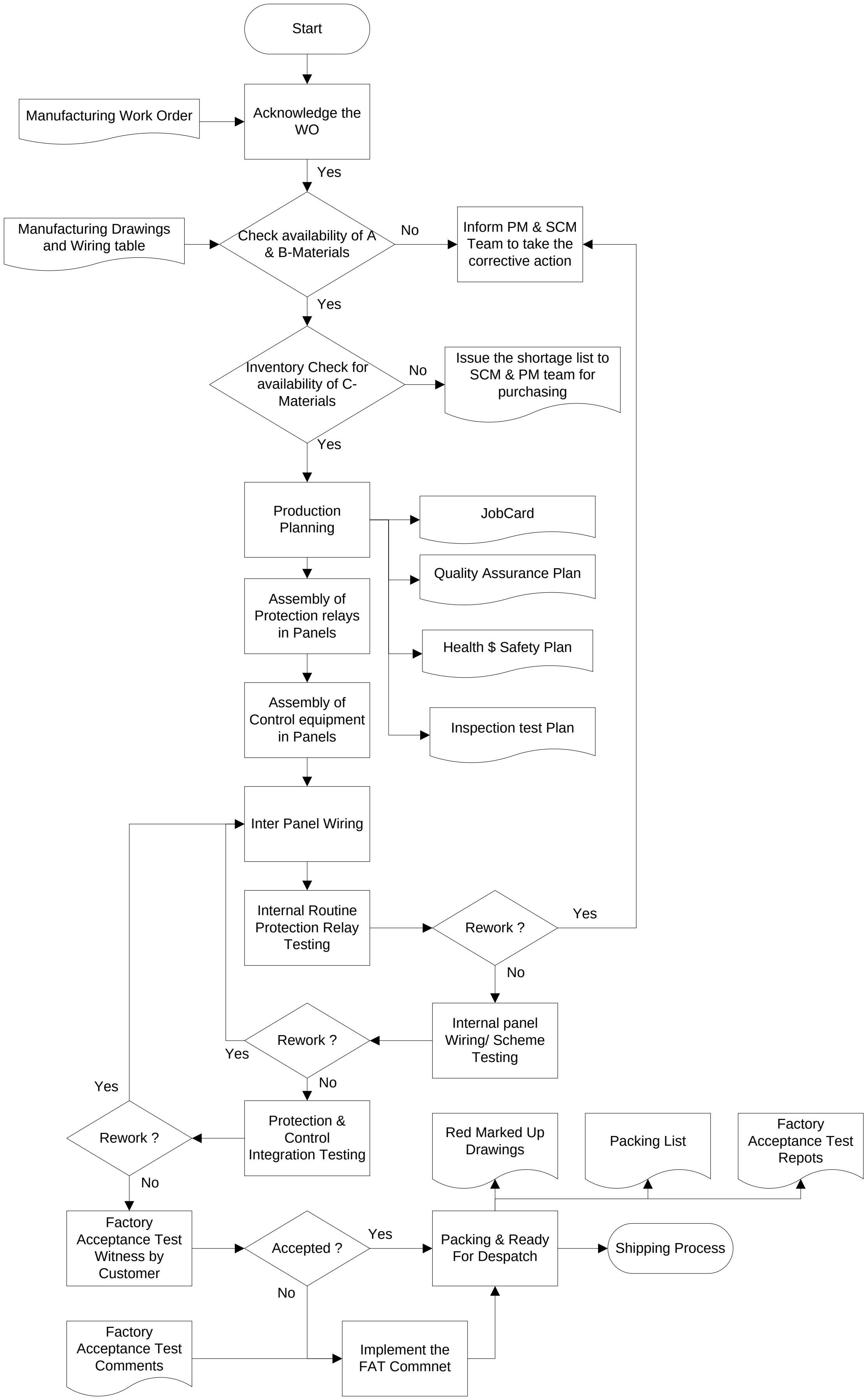


Process 27 – Developed Purchasing Process Overview

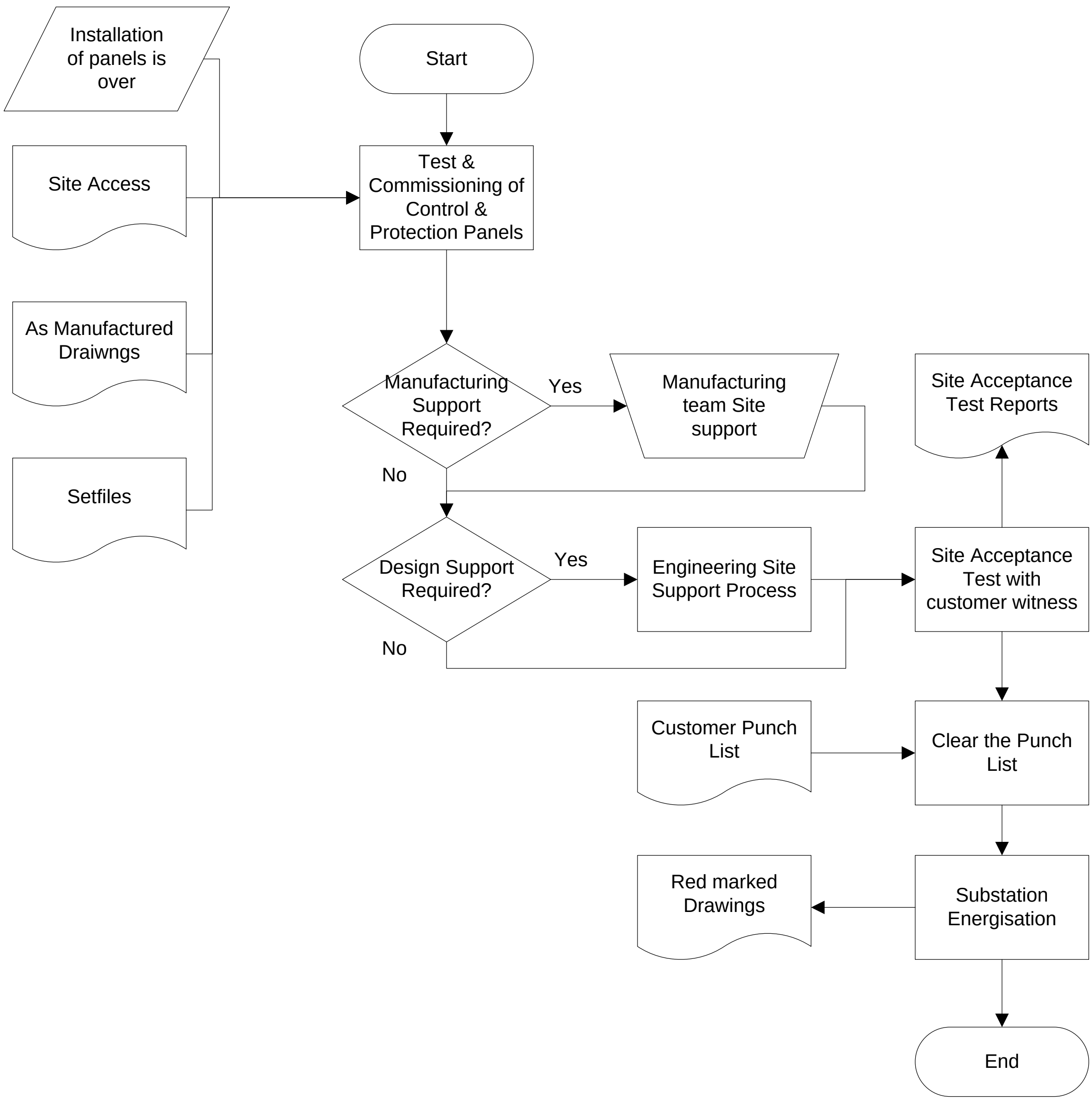


Process 28 – Developed Shipping Process Overview

5. Analysis



Process 29 – Developed Manufacturing Process Overview



Process 30 – Developed Test & Commissioning Process Overview

5.4.3. Results of Pilot Project:

As mentioned earlier, the new integrated process model (i.e. smart execution gate model) implemented during the project execution of Khalifa port Project as a pilot project. The scope of work was supply, design, manufacturing, factory test, delivery and test & commissioning of all control & protection panels and substation automation control system for three substations (i.e. substation1, 2 & 3) which was about 21 panels per substation. All the project milestone dates have been recorded and all the functional project team members (i.e. smart execution project team members) used the redesigned management processes.

Analysis of pilot project results - in compare to table1 which has been shown in page 69 (i.e. section 5.1), some changes happened;

a. Design/ engineering time consuming. Earlier was about 195 days while with implementing the new processes it has changed to 150days. The reason was application of 15% and 50% design review meetings. In design review meetings the expected time for getting feedback (i.e. comments or approvals would be communicated to customer) and that close communication with customer would highlight the project critical path and milestones by project and design team frequently.

b. With engagement of customer in design review meetings the waiting time has been reduced enormously. Earlier the waiting time at each stage was about 4-6 weeks while with new process (i.e. gate review meetings with engagement of customer in 15% & 50% design review meetings) customer approvals on drawings came back in2-3 weeks.

c. In addition, in order to reduce the site reworks (i.e. sending of manufacturing team or design team to site for resolving the technical or wiring problems), we specified longer time for incorporation of Factory acceptance test comment in ABB factory. Because, earlier only major comments would be resolved in factory and all other issues (i.e. any wiring issues or changes in circuits and etc.) would be rectified at site. And usually due to unavailability of manufacturing team, or required tools or any other reason that activity would be lasted longer which could impact on test & commission team activities and consequently impacted on entire project schedule.

d. The duration of procurement has been increased but since it has been started in early stage of project, there was no time impact on project delivery date. It happened due to running activities in parallel (i.e. application of concurrency). Moreover, application of material classification strategy helped to manufacturing and supply chain team to work smoothly. The supply chain management team started to purchase the material-A after getting approval on base design and material-B has been orderd after getting approval on detail design. So, purchasing of material-A was in parallel with detail design which saved a lot of time during the project execution. In addition, material-C have been consumed from inventory only and to extra time wasted for purchasing of material-C.

Additional improvement which helped in project delivery time was site support processes from manufacturing team and design team to test & commissioning team. Earlier there was no actual process for site support from design or manufacturing team, and then it could take very long time. Or due to lack of such processes, nobody took responsibility to resolve the site issues, then test & commissioning team had to take responsibility and resolve all technical and wiring issues at site. Apart from usual problem which has been mentioned in item c (i.e. unavailability of material or required tool) the problem solving at site activity itself would make the commissioning engineer busy and distracted from their actual work. So, the additional problem could come up. For instance; a dedicated and skilled resource would be busy for longer time at site X to resolve any simple issue (i.e. wiring issue in the panels or changing a damaged MCB in the panel) and that delay in project X would impact on start date of site works of Project Y. In other words, the test & commissioning functional unit usually had shortage of resources due to staying at site longer. They could finish their work earlier if they get more support from manufacturing or design team and they could be busy with their actual business. Those support processes in bigger picture helped to reduce the wasting time of skilled person at site.

The results have been shown in table1;

<table>
<tr><th colspan="2">Resource Involvement</th><th>Project Task</th><th>Duration / Days</th></tr>
<tr><td rowspan="11">Project Management</td><td>Sales Person</td><td>Customer Award the contract to ABB – 13.02.2010</td><td>1</td></tr>
<tr><td>Sales Person</td><td>Project Hand Over from sales to Project – 15.02.2010</td><td>3</td></tr>
<tr><td>Design engineer / Draft man</td><td>Design – Base
from 15.02.2010 to 15.04.2010</td><td rowspan="2">150</td></tr>
<tr><td>Design engineer / Draft man</td><td>Design – Details
from 15.04.2010 to 15.07.2010</td></tr>
<tr><td>Purchasing officer</td><td>Procurement
From 15.04.2010 to 25.07.2010</td><td>125</td></tr>
<tr><td>Production team</td><td>Production</td><td>31</td></tr>
<tr><td>Production team</td><td>Internal testing</td><td>10</td></tr>
<tr><td>Production team</td><td>FAT with Customer Witness
FAT comments incorporation</td><td>5
20</td></tr>
<tr><td>Production team</td><td>Packing & dispatch</td><td>5</td></tr>
<tr><td>-</td><td>Waiting for Customer Approvals in different stages</td><td>70</td></tr>
<tr><td>Commissioning Team</td><td>Test & Commissioning</td><td>60</td></tr>
<tr><td colspan="3">Khalifa Port project typical TPT</td><td>41</td></tr>
<tr><td colspan="3">Khalifa Port project typical TTPT without Customer Approval time</td><td>225</td></tr>
</table>

Khalifa Port project typical TTPT with Customer Approval time	295
Khalifa Port project typical DT	355

Table1

In addition, Chart1 shows the khalifa port project total Throughput time, chart2 shows the khalifa port project throughout time of the project, chart3 shows the khalifa port project's contractual and actual total throughput time record and finaly chart4 shows the khalifa port project's OTD% (i.e. project KPI).

As summary, the implementation of smart execution gate model as an integrated process model caused some improvements in pilot project which shows that that process model could be implemented in entire organization (i.e. PSN business unit of ABB UAE organisation). According to improved OTD% - as the most important and measurable Project KPI – from 73% in best case of previous projects records to about 90% in khalifa port project, the current research could have positive impact on PSN business unit operation.

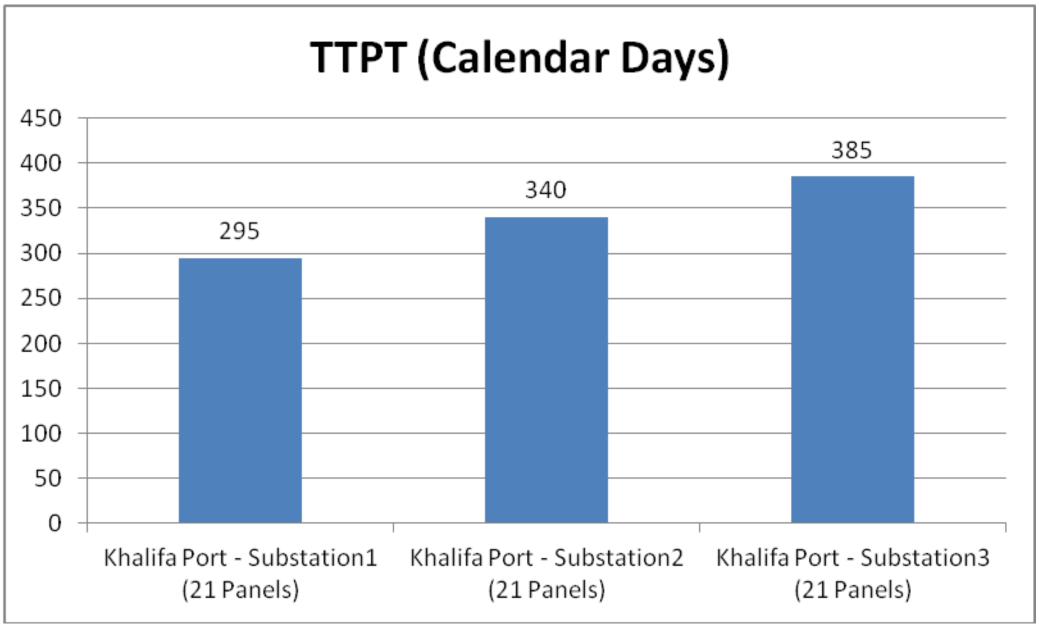


Chart1 – Pilot Project TTPT

5. Analysis

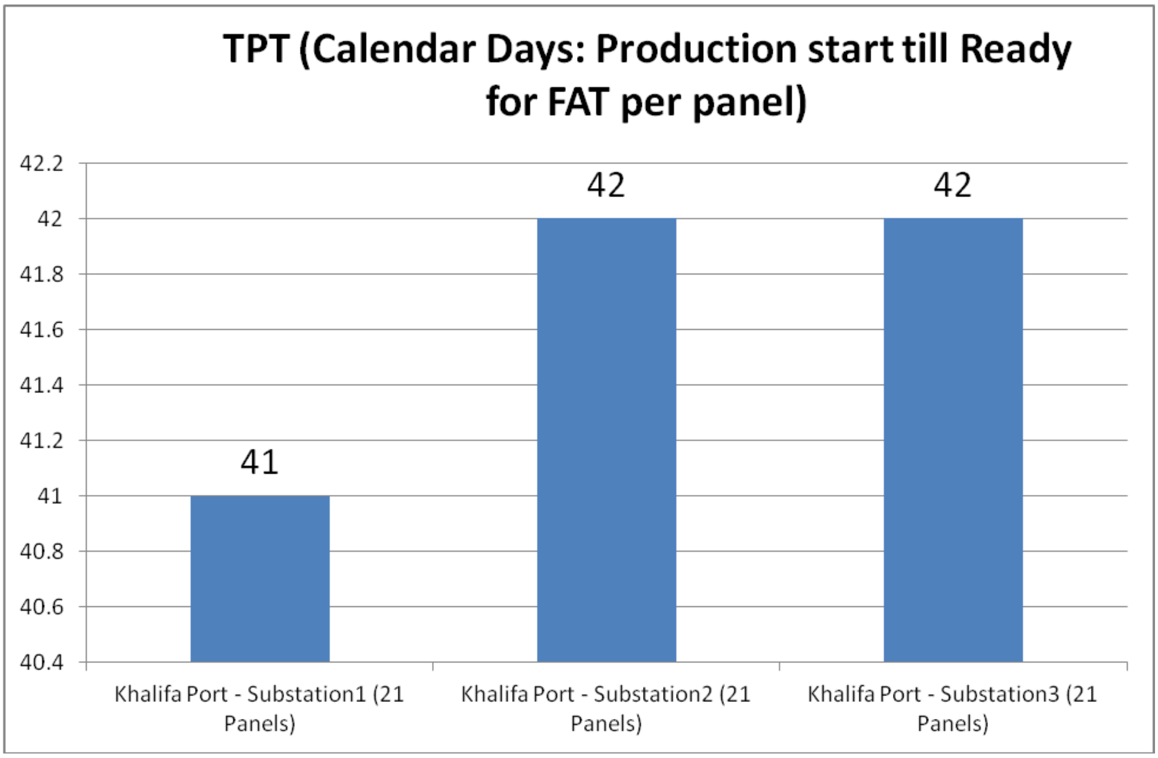


Chart2 – Pilot Project TPT

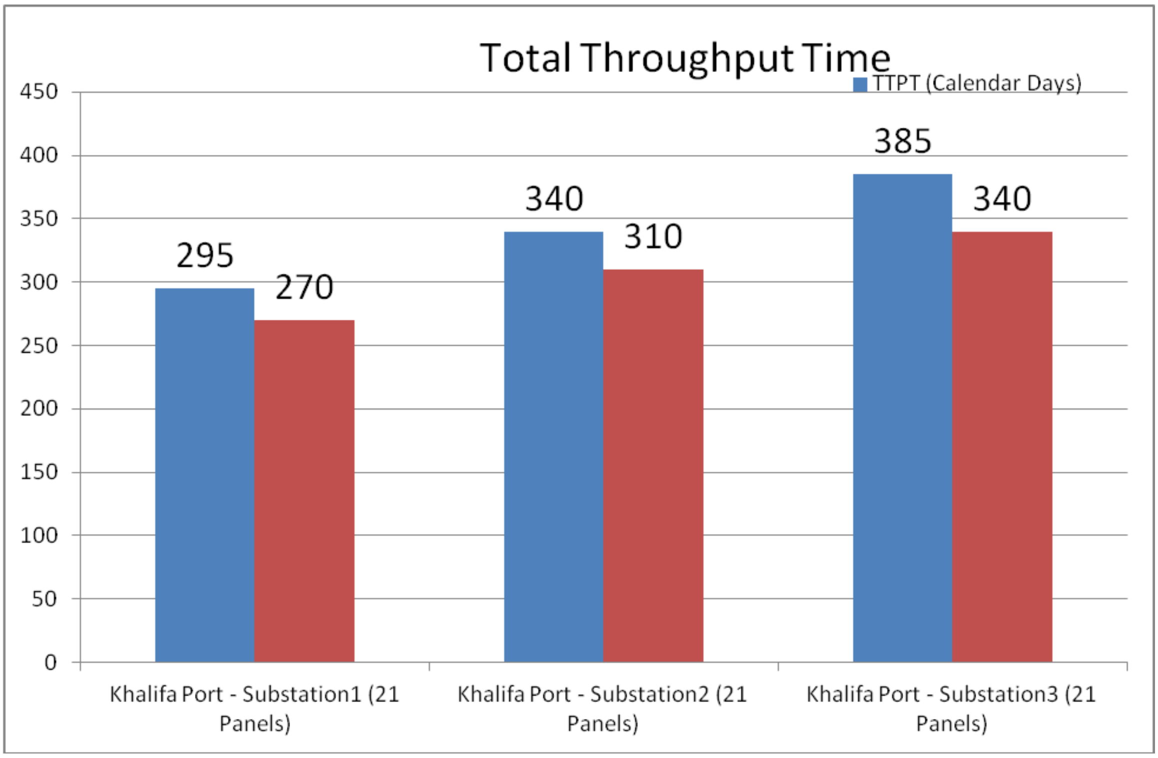


Chart3 – Pilot Project contractual and actual TTPT

5. Analysis

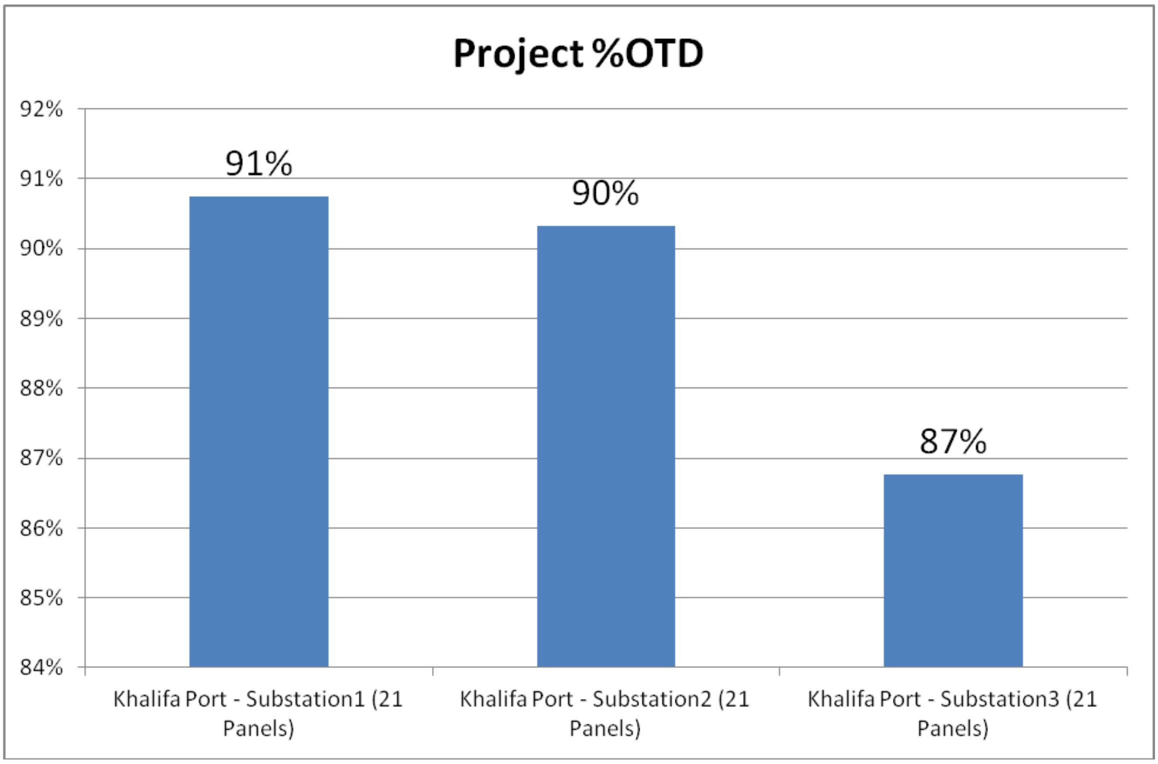


Chart4 – Pilot Project OTD% - Project KPI

6. Conclusion & Recommendation

6.1 Conclusion:

The manufacturing sector is nowadays characterized by a continuously increasing level of complexity, basically because of both large number of requirements that must be met at a production level and the presence of many different sources of uncertainties in the market. This high level of complexity affects both the physical and architectural aspects of manufacturing companies, together with the managerial, financial and organizational aspects (Colledani et al. 2008).So, in order to survive in the currently competitive and global business environment, most enterprises are struggling to change their existing business processes into more agile, product and customer oriented structures (Han and Park, 2009).

This research covered the development of an integrated gate process model (i.e. smart execution gate model) and redesigning of all management process at PSN business unit of ABB UAE which is a project based organization and the model validated through a pilot project (i.e. Khalifa port project). The result of pilot project and research findings showed some improvements in terms of project total cost and delivery time.

6.2 Recommendations:

As already mentioned in pilot project results, some improvements have been achieved in project execution at PSN business unit in terms of project delivery time, TPT, TTPT and OTD% (i.e. KPI). So, in light of this, the following recommendations are made:

1- Application of gate model in project execution which could cause close communication among the project team during the project execution. That would be opportunity for all functional units to plan earlier in terms of time and resources. For example; in some projects, there would be requirement for some specific technical skill or tools, so, the design manager could plan for it earlier. They could order the required tool without having time impact on project execution or design engineer could be trained and be ready to do the job without time impact to project delivery time.

2- Gate model could be helpful in having close communication with customer. Involvement of customer projects' gate review meetings and frequent meetings would highlight the project critical path and it may impact on entire project organization. In some cases project owner or customer could help in project execution, if they are aware of project requirements. For instance, they could help to improve the project cash flow or issuance of contractual clearances or certificates.

3- Definition of roles and responsibilities could help to project progress in terms of usage of dedicated and skilled resources in required filed. As mentioned, dedicated resources would be waste of time to resolve simple works as, they could be transferred to work in another project.

4- Early involvement of project management team (i.e. in sales stage) could reduce the amount of reworks during the project execution. For instance; when PM – which has got experience of execution f previous projects, involve in sales negotiation stage, the amount of reworks would be reduced in the future stages of the project. Usually in power system industry some technical complications will happen during the factory test or test & commissioning at sites and there would be cost and time impact for entire project delivery time. So, if those problems and resolutions are not considered in coming projects, then project team should deal with repetitive problems in all the projects. So, early involvement and consideration of cost impact and time impact would reduce the amount of cost of poor quality in PSN business unit or any other project based organizations.

5- Knowledge management and application of lessons learned in previous projects in a project organization could cause less cost implications in future projects. Having the project close out meeting and recording the project latest status and transferring that knowledge to bids and marketing team would cause significant reduction in amount of cost of poor quality in project execution. For example, getting feedback from supply chain team, design team or test & commission team by bids and marketing team about the latest material price or the amount of consumed man-hours of all functional units (i.e. design team, project management team, test & commissioning team and so on) would help sales team to come up with more accurate estimations.

6.3 Recommendation for Further studies:

The developed gate process model and newly developed management processes are validated in project execution stage only (i.e. after handing over the project from Sales to Project team) and the validation of new bids & marketing processes is missing. Since, the developed set of management processes and integrated gate model was implemented in project execution only, the most worthwhile recommendation for further studies would be validation of all processes (i.e. including the bids & marketing processes as well) for one more project before implementation in entire organization. In fact, the missing part is related to item 5 of research findings which is about knowledge management in project organization. So, if the complete set of developed processes would be validated through project total delivery time (i.e. according to Fig.5 – Chapter5), the second pilot project result would show more improvements in terms of project total cost and delivery time and consequently give a better picture to higher management for implementation of processes in entire organization.

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