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# A Review of Quality Relationship between IT Processes, IT Products and IT Services

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***Abstract*—**Producing IT products/services required carefully designed. IT development process is intangible and labour intensive. Making optimal use of available resources, both soft (knowledge, skill-set etc.) and hard (computer system, ancillary equipment etc.), is vital if IT development is to achieve sensible economical advantages. Apart from the norm of Project Life Cycle and System Development Life Cycle (SDLC), there is an urgent need to establish a general yet widely acceptable guideline on the most effective and efficient way to precede an IT project in the broader view of Product Life Cycle. The current paper proposes such a framework with two major areas of concern: (1) an integration of IT Products and IT Services within an existing IT Process architecture and; (2) how IT Product and IT Services are built into the framework of Product Life Cycle, Project Life Cycle and SDLC.

***Keywords*—**Mapping of Quality Relationship, IT Processes/IT Products/IT Services, Product Life Cycle, System Development Life Cycle.



## I. Introduction

OVER the years, rapid expansion of the IT role has taken place in many industries, from simply assisting and supporting business activities to managing and controlling IT related processes. The maturity level of an IT process is greatly depends on how accurately the process is defined, measured and controlled throughout its' development cycle [1]. Much attention is given to IT processes which are often used as a measurement indicator of respective company's maturity level and quality management. In this aspect, IT companies are striving to achieve highly matured processes with the aim of producing acceptable and high quality outputs [1].

According to Fitzgerald [2], there is a common "IT crisis" whereby IT products and/or IT services are taking too long to develop, costing too much, and not working very well when eventually delivered. The main reasons are attributed to undisciplined, chaotic and completely unpredictable software processes [2]. In order to make obscure IT processes more visible and structured, several development processes such as the Waterfall, Prototyping, Spiral, and Iterative were developed. No matter which development methodology is adopted, the bottom line is to ensure IT companies are adhering to a structured and systematic approach in planning, managing and controlling the creation of an IT Product/Process/Service.

There are many publications where the authors attempted to establish the relationship of Product Life Cycle, Project Life Cycle and SDLC. However, most of these literature papers focus on two cycles and neglect the other one, i.e. the relationship between Project Life Cycle and SDLC are openly discussed, quoted and adopted by many researchers and companies; and at the same time it is being published and shared as teaching resources [3]-[8] among university instructors. This relationship between Project Life Cycle and SDLC has become a fundamental and compulsory topic for every IT-related course. As such, the majority of IT students are exposed only to these two limiting cycles where the broader view of Project Life Cycle and SDLC within the Product Life Cycle is being neglected or ignored. This may explain why most IT teams are eager to push the product out of the door and willing to sacrifice product quality; as they can shoulder the responsibility to another team who handle customer complaints after the product launches. These irresponsible and wrong perceptions among IT specialists have created a burden for companies over the past few decades; having a negative impact not limited to dollar and cents spend on rework but seriously affecting team morale, motivation and company culture.

Nevertheless, most IT specialists do not view an IT Product or IT Service just like other non-IT Product or non-IT Service; which does not stop at the production stage but requires traversing the stages of adaptation, sustaining/growth/sales/marketing and end-of-life. In short, handling of product quality should be viewed from the product life cycle perspective and not limited to the production stage alone, i.e. Project Life Cycle and SDLC. After all, problems arise from customer complaints and/or customer dissatisfaction will eventually affect the development team again.

This study involves literature analysis with an aim to understand the interrelationship and subsequently determine the correlation between IT Processes, IT Products and IT Services; and highlight how they affect quality; thereby getting closer to identifying the importance of IT Processes that is truly a vital segment to the quality of IT Products and

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IT Services. It is hopeful that the resulting framework capable of creating wider awareness among IT project teams of the importance of IT Processes and Product Life Cycle as a core factor affecting the overall product's quality; and understand how these three IT areas can be fitted into Product Life Cycle, Project Life Cycle and SDLC.

## II. Definition Of IT Process, IT Product, IT Service, Product Life Cycle, Project Life Cycle and SDLC

*IT Process* is a sequence of interdependent and linked procedures; which at every stage consumes one or more resources (employee time, effort, knowledge, expertise, energy, machines, money etc) to convert inputs (data, material, parts, etc.) into outputs. These outputs then serve as inputs for the next stage depending on business nature until a known goal or end result is reached.

In IT project management, hardware and software are the two main components of *IT Product* deliverables. The term computer hardware is best described as all the physical parts of your computer and related devices, or the parts you can feel and touch. Software consists of carefully-organized instructions and codes written by programmers in any of the various special computer languages and may come in several forms: single programs like script interpreters, packages containing a compiler, linker, and other tools; and large suites. Software is often broken into two major categories: system software and application software.

System software is responsible for controlling, integrating, and managing the individual hardware components of a computer system so that other software and the users of the system see it as a functional unit without having to be concerned with the low-level details. Application software handles multitudes of common and specialized tasks a user wants to perform, such as accounting, communicating, data processing, word processing etc.

*IT Services* is a set of IT business strategy solutions and a systematic methodology which leads to breakthrough in profitability through quantum gains in service quality, customer satisfaction and productivity. The key philosophy for IT Services Management is to continuously reduce faults/delays/variation in service processes with the aim to reduce customer dissatisfactions, delays, defects or failure from every product, service and transactional process [3]. Table I outlines the summary of some IT service solutions implemented in different service industries.

TABLE I
EXAMPLE OF IT SERVICE SOLUTIONS

| No | Organization | IT Services |
|---|---|---|
| 1. | **International private banking** [4], [5] | Using software to handle wire-transfer operation to reduce delayed, improve customer satisfaction, retain valued customer, improve company reputation, improve transfer cycle time, reduce cost-per-payment and improve annual saving |
| 2. | **Lending mortgage banking firms** [4] | Loan processing platform using "Clientele" software to increase customer satisfaction, improve response time, reduce abandoned customer call, reduce process redundancies, improve loan retention, elimination of risk exposure and improve annual saving |
| 3. | **Private branch exchange dealer/distributor** [4] | Developed a database to track life-cycle-order for sales-to-cash interval to reduce interval time, improve annual saving, increase accuracy and timeliness of customer billing, improve forecasting accuracy, reduce internal cost, improve collection process and reduce excessive delays |
| 4. | **Healthcare Industry** [6] | Application software assistance in handling and increase radiology throughput, decrease cost-per-radiology procedure and improve annual savings |
| 5. | **Telecommunication provider** [4] | Implement a new call strategy software for business market collection to reduce defects in collection processes, improve collection-cycle-day and improve revenue |

*Systems Development Life Cycle (SDLC)* is a framework describing the phases involved in developing information systems [7]-[9]. SDLC is a conceptual model used in project management that describes the stages involved in an information system development project, from an initial feasibility study through maintenance of the completed application. The primary objectives of SDLC are to ensure high quality systems are delivered, provide strong management controls over the projects, and maximize the productivity of the systems staff [7], [10]. In the first *Planning* phase, an organization's information needs are examined as a whole where project needs are prioritized and translated into a plan; followed by an *Analysis* phase, where requirements study and requirements restructuring are performed; a *Design* phase where analysts convert the description of the recommended alternative solutions into logical and then physical system specifications; and at *Implementation* phase; where analysts convert system specifications/documentation into a working system that is tested and then put into use; and lastly a *Maintenance* phase, where programmers make changes based on users' feedback and modify the systems to reflect changing business conditions.

The *Project Life Cycle* refers to a logical sequence of activities to accomplish the project's goals or objectives [11]. Regardless of scope or complexity, any project goes through a series of stages during its life. There is first an *Initiation* or Birth phase, in which the outputs and critical success factors are defined; followed by the *Planning* phase, characterized by

breaking down the project into smaller manageable parts/tasks; an *Execution* phase, in which the project plan is executed; a *Monitoring* phase, where actual project activities are benchmark against baseline; and lastly a *Closure* or Exit phase, that marks the completion of the project [10], [11].

The *Product Life Cycle* is a marketing theory cycle or succession of strategies experienced by every product which begins with a product's introduction/initiation, sometimes referenced as research and development, followed by its product development, product adoption, then sustaining and finally market saturation and decline/end-of-life [12]. The Product Life Cycle goes through many phases, involves many professional disciplines, and requires many skills, tools and processes. Product life cycle has to do with the life of a product in the market with respect to business/commercial costs and sales measures. To say that a product has a life cycle is to assert four things: (1) products have a limited life, (2) product sales pass through distinct stages, each posing different challenges, opportunities, and problems to the seller, (3) profits rise and fall at different stages of product life cycle, and (4) products require different marketing, financial, manufacturing, purchasing, and human resource strategies in each life cycle stage.

## III. The Mapping of Product Life Cycle, Project Life Cycle and System Development Life Cycle

According to Koppensteiner and InterGlobe Consulting firm [12], [13], the project life cycle has to be applied to the product development phase and the product adaptation phase of the product life cycle. Any product (IT and non-IT) is developed during the product development phase by at least following the project life cycle once. When the product development phase is completed, the product is delivered to the market. A new product is always vulnerable to product competition among existing market segments such as product replacement and product switching; and other threats affecting sales growth of the product as being the new entrant to the market space. In view of additional market needs and demands, the product requires an adaptation phase where a revised or improved product is delivered to the market. Whether the product is capable of sustaining in the market, it is necessary to find out how big the existing customer base that is actively using the product; and if the customers are ready to use the new product. By doing so, respective resources supporting this product can be shifted to next in-line product development. Product review is a crucial checkpoint whenever it moves from one phase to the next. This reviewed outcome will help management gather much information to make relevant decisions for the next phase. When the product reaches the Sustaining stage where sales are declining, this product will come to its' end-of-life if all customers have transferred to the new product.

In project management, a project can be defined both with a Project Life Cycle and an SDLC, during which slightly different activities occur. According to Taylor [14], the Project Life Cycle encompasses all the activities of the project, while the SDLC focuses on realizing the product requirements. In the IT industry, SDLC is commonly used during the development of an IT project, it describes the different stages involved in the project from the drawing board, through to the completion of the project. In the middle of the project life cycle (execution phase), the certainty of completing a project improves when more resources are needed and involved [7], [10]. This is the stage where everyone (tester, programmer, system analyst, project leader, project manager, document writer etc.) is involved and investing effort and time hoping to deliver a quality product. Failure to deliver during this stage results in cost overrun where rework is needed. Since the IT development process is expensive and labor intensive [15], it is always wise to follow a proven structured and systematic approach of SDLC to increase the success rate of product development [2].

The relationship between Product Life Cycle and Project Life Cycle has been discussed by the InterGlobe Consulting firm [13] where respective Project Life Cycles are nested into the Product Development phase as well as Product Adaptation phase. This clearly shows that in a real business environment, all products (IT and non-IT) are mandated to go through product life cycle once and n-times of Project Life Cycles and x-times SLDCs depending on business needs, user perception and acceptance level of product's quality. In conclusion, the broader view inter-relationship between these three cycles is summarized and represented in Fig. 1.

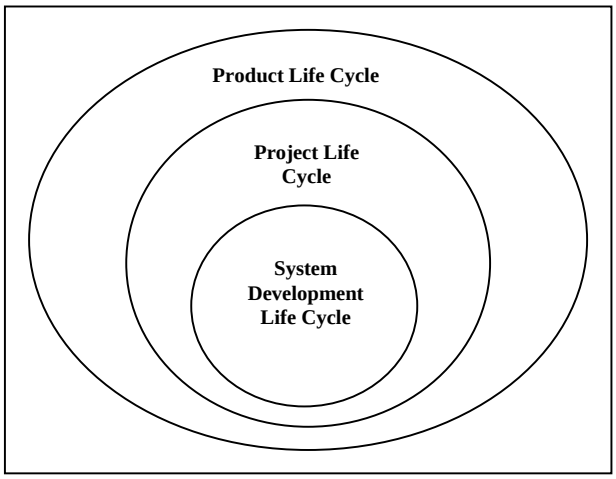


Fig. 1 The Relationship Between Product Life Cycle, Project Life Cycle and SDLC

## IV. The Relationship between IT Process, IT Product and IT Service

With today's increasingly competitive economy, IT organizations place great emphasis on operational process management to ensure IT product/service is systematically managed and controlled to achieve better customer satisfaction, better quality, increase revenue growth and employee productivity gains. However, misconceptions arise among management teams being overly focus and emphasize solely on the output and neglect the operational processes

while developing the product. In many cases, the reviews and discussions of these three IT business areas are always isolated and independent leading to a misunderstanding that these three business areas can be dealt with separately and successfully. In reality, IT Processes are the heart-of-quality which involves a series of stages/phases transforming/converting input into output. All IT Products and IT Services are mandated to traverse across the stages/phases of IT Process or Product Life Cycle consisting x-number of Project Life Cycle and SDLC depending on the business nature.

Products can appear in various forms ranging from a good, an idea, a method, information, an object, or service that is the end result of a process and serves as a need or want satisfier. In marketing, a product is anything that can be offered to a market that might satisfy a want or need. In retailing, products are called merchandise. In manufacturing, products are purchased as raw materials and sold as finished goods. In insurance, the policies are considered products offered for sale by the insurance company that created the contract. In investment institutions, customized investment plans are the end products companies offer to their investors. Therefore, an IT "product" need not always be a "machine" related item as it greatly depends on the respective business nature.

In most cases, the development of an IT Product (e.g. customized software) will be seen as "a" project (Project-A) to a project team (e.g. Team-A) where resources, time and effort are spent to deliver the IT Product on time, within budget and adhere to user requirements. Even though the general rule of thumb is to allocate two third (66.67%) of total project time for product testing, many project managers are willing to risk and sacrifice product quality by shortening the testing time-frame just to push the end product to the market place and then move on to next project. The popularity of IT services is growing every day, many IT firms and non-IT firms are focusing their efforts on service-oriented processes with the aims of achieving maximum return on investment [16]. As a result, it has been a shift in organization' focus from traditional technology management to service quality and customer relationship management (CRM) [17]. Due to the increasing and endless demand from customers, many IT Products somehow have its product life cycle extended in handling customer requests, complaints, suggestions etc. as a means of CRM.

In general, IT specialists view IT Products and/or IT Services as a separate entity due to the nature of project management. Many IT Products are pushed to the door to meet product launch-date commitments and project deadline, and thereafter organizations are "forced" to implement IT Services as a mean of "norm" for "after sales service" in collection of user acceptance and product satisfaction due to market pressure in supporting CRM. This approach lacks effort, attention and emphasis given to IT Processes and places tremendous negative impact on the IT product life cycle (i.e. IT Products and IT Services) especially in both the Product Adaptation and Sustaining phases; and at the same time creating threats and challenges to the support teams. This "after sales service" was seen as a "survival-kit" in this competitive red-sea IT market segment where companies believe in "user acceptable of product's quality will foster customer loyalty" especially in the long run.

In supporting the IT service organization, IT executives and managers are challenged to transform their organization from delivering technology to providing services and ultimately becoming a business partner within the organization [18]. A Helpdesk system, Telephone Assisted Software or TeleClient, Forum etc. are some examples of commonly used CRM medium for most IT Products. These CRM mediums require IT platforms (i.e. any combination of networking, software, hardware etc.) in handling the vast volume of data so that accurate and valuable information can be computed and analyzed in real-time; providing ad-hoc assistance to management in decision making processes as well as future business forecasting.

This CRM medium (i.e. IT Services) will be treated as a new project (Project-B) by another team (e.g. Team-B) which normally goes hand-in-hand from the day the software was launched. In view of different skills set requirement (hard and soft skills) for Project-A and Project-B, resource sharing between Project-A and Project-B are normally kept to a minimum. The input of the CRM medium is actually the software developed earlier by Team-A. If in any circumstance when a portion of the software quality was being risked to meet project deadline by Team-A, it can be foreseen that Team-B will receive many complaints due to customer dissatisfactions as a result of poor quality software. By then when the software was put into used in real-life day-to-day operation, Team-B may have received a long list of reported software bugs with different severity levels (i.e. low, medium and high). If there is any reported high-impact bug(s) causing system halts or disrupting business routine operations, immediate attention is required from both teams (Team-A and Team-B) to plan for a fix-release or a patch-release (i.e. Service pack for Microsoft Product) as part of the project life cycle. This fix-release or patch-release may be treated as a new project (Project-C) again if there are many changes needed to the source code. The same process will go on until a stage when the software reaches the EXIT point where the company decides to prosper with new software.

In short, both the management team and project team should view both IT Products and IT Services as *ONE dependent* entity within the product life cycle. This could lead to better controlling, managing and handling of product quality and customer satisfaction. The detailed development activities from IT Products to IT Services or vice versa are in a recursive loop within the boundary of IT Processes as shown in Fig. 2.

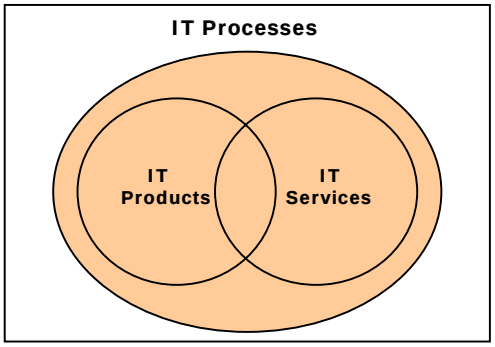


Fig. 2 The Relationship Between IT Processes, IT Products and IT Services

There exists a strong and linear relationship between IT Process, IT Product and IT Service; and the ability to properly manage one segment (IT Processes) will result in overall performance improvements ranging from output quality, delivery, satisfaction, and sustain for improvement in competitiveness. This means all IT products have a particular life span, which is called the product life cycle. The length of time a product is on the market is largely contingent upon its competition, technology and even the savvy of a company's marketing department. One of the best ways of extending a product's life cycle is to continuously garner feedback from consumers, finding out what they need and want from a particular product.



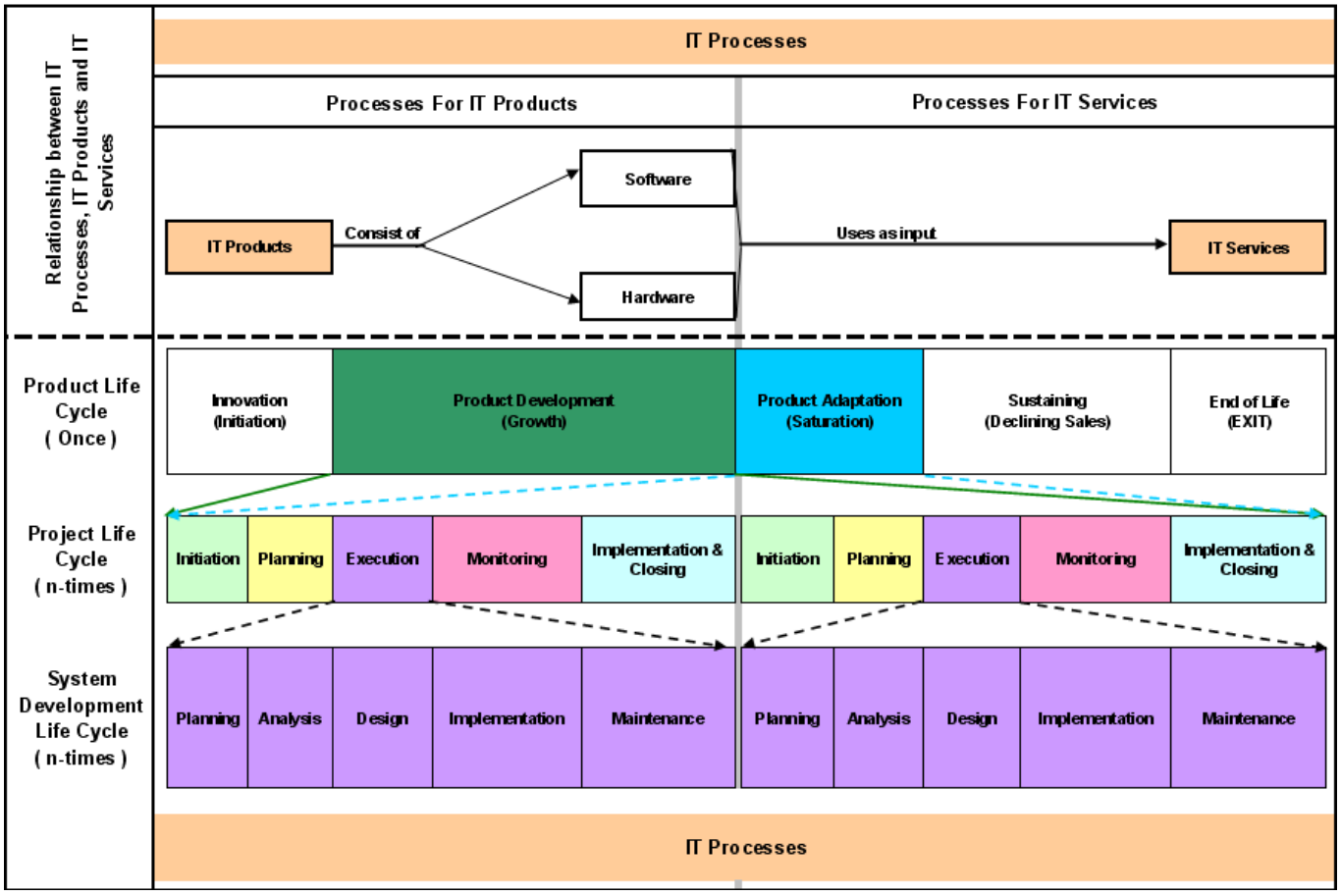


Fig. 3 The Mapping Relationship Between IT Processes, IT Products and IT Services Within the Project Life Cycle, Project Life Cycle and SDLC

In order to better illustrate the relationship between IT Process with both IT Products and IT Services, a mapping of their relationship between IT Processes, IT Products and IT Services within the Project Life Cycle, Project Life Cycle and SDLC is proposed in Fig. 3. Whether it is IT Products or IT Services, it is necessary for an IT Process stage of phased spammed over the entire product life cycle; where an input is transformed into an output. These outputs may also be inputs for other IT business segments further on a later stage. The existence of a relationship between IT Process, IT Products and IT Services does not mean that quality is completely and solely addressed by IT Processes; but the outputs of the IT Product have significant impact on IT Services while further affecting customer expectation and customer satisfaction; and at last impacting the life cycle of the IT Product. The reliability of the product has a direct relationship with the way the product is developed. For IT Products and IT Services improvement and maintenance, a higher emphasis should be

set to address the IT Process flow which would further strengthen the quality of IT product and IT service. By putting more effort and resources in the activities of IT Processes where proactive planning are in place could lead to better achievement in quality and understanding of the relationship between IT Products, IT Services and IT Processes to reduce rework which cost 8-10 times more than the original plan [10]. This is the main reason why Vaishnavi [19] views the relationship between IT product structure and product maintainability as an important research issue to be addressed in near future.

A survey conducted by Hairul [30] has proven a strong linear relationship between high-quality IT development processes and high quality products. Therefore, it is important for IT companies paying more attention not only in the IT development cycle but also a more general view of IT Products and IT Services within IT Processes in the Product Life Cycle. In particularly, the literature and business reviews in IT industry are extremely diversified into three segments; i.e. IT processes, IT services and IT products; with IT processes dominating the population followed by IT services and IT Products [31]. Even though these three IT business areas are frequently discussed and reviewed independently, the outcome of each review is generally falls into the category of IT Product or IT Services or both as shown in Table II. Table II summarized the adoption of different quality improvement initiatives specifically in the area of IT processes; which in turn expecting to enhance the quality and consistency of IT Product and IT Service delivery in IT organizations. This can further prove that the ultimate outputs of IT development process can be categorized into IT Products and IT Services respectively.

TABLE II
ADOPTION OF DIFFERENT QIMS IN IT PROCESSES

| Title of Literature/Business Review and Brief Explanation | IT Product | IT Service |
|---|---|---|
| **Using Human Resource Management Suites To Exploit Team Process Improvement Models [20]** - This research examines the degree of support of an IT product of Human Resource Management System (HRMS) Suite of Oracle Applications ERP System; on how and to what extent do HRMS applications support organizations to adapt team **process improvement** models for operational routine. | √ | |
| **The current state of six sigma application in services** [21] - This emerging field of study looking for **process improvement directions** to take the application of six sigma (DMAIC) process further in services (IT and non-IT) industry | | √ |
| **New Research Customer-Centric Six Sigma Quality and Reliability Management** [22] - This paper presents a customer-centric six sigma quality management as an extension of the traditional six sigma way; where the author views **product quality and process reliability** as key to achieving and adopting a holistic view of quality | | √ |
| **Six Sigma for Service Processes** [5] - This paper aims to demonstrates the power of six sigma, a **process disciplined approach** to improving product, process or service quality in the IT industry | | √ |
| **CRM Adoption Success Factor Analysis and Six Sigma DMAIC Application** [23] - This paper propose a strategy to integrate Six Sigma DMAIC methodology with the CRM implementation process emphasizing the **critical part of implementation process** as a basis for to provide high possibility of CRM adoption success. | | √ |
| **Carbon Footprinting of Information Technology Products based on ISO standards (Fujitsu Case Study)** [24] - Fujitsu is one of the drivers within the information technology (IT) industry analysed the resulting **Life Cycle Assessment** study of the selected Fujitsu IT products in its PC and server lines, **throughout the process of their product life cycle**. This initiative allows comparable emission calculations which allow helpful insights into the discharge of emissions throughout the complete value chain. | √ | |
| **Representation of Knowledge in Information Technology Service Capability Maturity Model (IT Service CMM)** [25] - A conceptual modelling language of Conceptual Model Quality Framework (CMQF) is selected and applied to the **IT Process in Service CMM** in order to enable identification of the collaboration requirements of various entities. This in turn is expected to enhance the quality and consistency of service delivery in IT service organisations that utilise the IT Service CMM. | | √ |
| **Signal Processing and Sys Design of Cylinder Reliability Test for ISO Standard** [26] - A study was conducted to analyze the requirement of cylinder reliability test system which involve careful studies in the **signal processing method**, develops solenoid valve drive circuit and the convert circuit and designs cylinder reliability test system. The applications show that the system runs reliably and meet the requirements of the cylinder reliability test. | √ | |
| **The Influence Of The Quality Standards IS0 9000 On Telecom Manufacturers** [27] - This paper describes how IS0 9000 standards are adopted and implemented in **operational process** of the Public Switching Division of Siemens AG manufacturers and carriers of telecommunications systems operating worldwide with the aim for uniform quality standards. | √ | |
| **Software Process Improvement via IS0 9000? Results of two surveys among European software houses** [28] - This paper presents and sharing of result outcome of two surveys implemented successfully among European software houses in software process improvement via ISO 9000 as part of the operational activities | √ | |
| **Evolution of a Software Maintenance Organization from Cost Center to Service Center** [29] - This paper describes the evolution of a software maintenance organization for digital set-top boxes of a leading electronics company from a cost center towards a service center by adopting ITIL service support in the IT process implementation to develop a better customer focused approach for a professional, self-supporting maintenance organization | | √ |

## V. Conclusion

The quality of IT products is largely governed by the quality of the process used to build it [30]. It is important for engineers, executives and managers to understand the main purposes, advantages and disadvantages of each initiative and how various improvement initiatives can potentially fit together in an integrated approach. In short, it is crucial to have a deep understanding of how an organization operates or should operate as a system. From the financial viewpoint, it is always important that the product is commercially successful and that product handling effort is minimized with maximized earnings [32]. Quality is something very hard to define, but it is a measure about how confident the user is of the services in operator/vendor. It is always about quality and how the product behaves during live operations. However, fault-free product most likely will not be affordable [32].

The project life cycle is the link between product life cycle and methodology used for creating the IT Product and IT Services (i.e. SDLC). The positive relationship between IT Products and IT Services within the boundary of IT Processes; which further fit into the generic mapping framework linking Product Life Cycle, Project Life Cycle and SDLC helps in creating an awareness amongst the management teams and IT specialists about the right product quality expectation. This new phenomenon of thinking but mutually dependent life-cycles in IT business segments is in-line with one of Steven Covey's The *Seven Habits of Highly Effective People* [33], i.e. "Begin with the end in mind". As such, all IT specialists should view IT project-successes from a broader perspective of product life cycle from the start of the life cycle till the end-of-life of the end-product.

In conclusion, all IT Products and IT Services within the boundary of IT Processes will traverse product life cycle once; n-times of project life cycle and x-times of SDLC. The overall performances of IT Processes are greatly dependent on the quality of IT Products and IT Services. A well-perceived and accepted end-product from the end-user perspective should traverse all stages of product life cycle; not limiting to project life cycle only. By doing so, it drives operational excellence, product perfection, and elevates process maturity for now and in years to come. When the overall business processes are in place, the route to quality and operational excellence is the next milestone.

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