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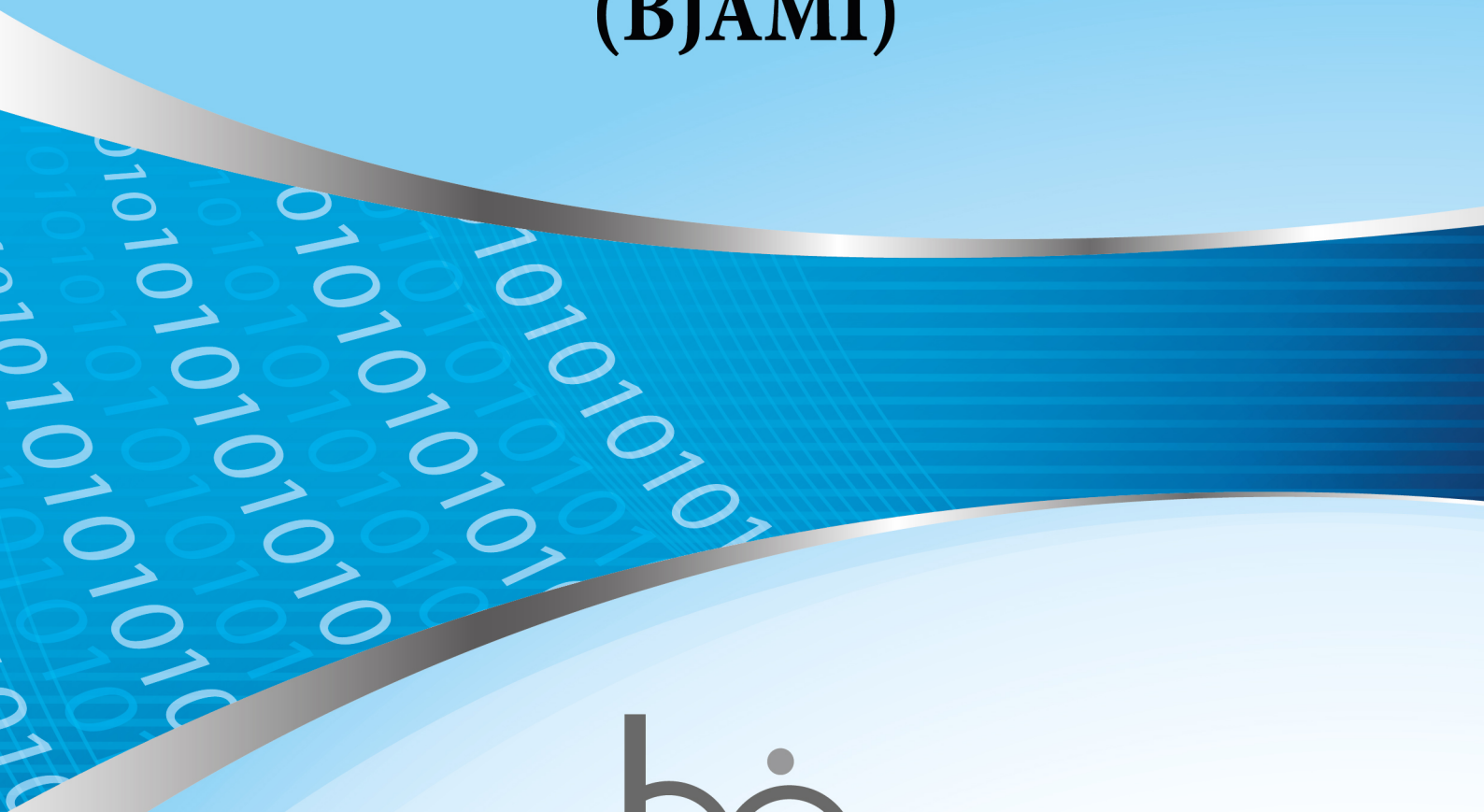

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CONTENT

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BUSINESS PROCESS MODELING, SYSTEM ENGINEERING AND THEIR APPROACH TO THEIR APPLICATION IN INDUSTRIAL CAPACITY

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Abstract. Most enterprises have a pretty good idea of the various business processes powering their daily operations. However, when they need to ensure that those processes consistently drive optimal outcomes, "a pretty good idea" is not enough. The primary objective of business process modeling tools is to analyze how things are right now and simulate how should they be carried out to achieve better results. If an organization wants research and development (R&D) investments to produce sufficient returns, IT issues resolved with minimal downtime or a highly accurate lead qualification workflow, it needs to understand these processes on an objective and comprehensive level. Even the business users directly involved in these processes may lack total transparency into what exactly happens at every step of the way.

1. Introduction

Business analysts can gain end-to-end views of the business process lifecycle through business process modeling; that is, a business process management (BPM) technique that creates data-driven visualizations of workflows. These process models help organizations document workflows, surface key metrics, pinpoint potential problems and intelligently automate processes.

A business process model is a graphical representation of a business process or workflow and its related sub-processes. Process modeling generates comprehensive, quantitative activity diagrams and flowcharts containing critical insights into the functioning of a given process, including the following:

- Events and activities that occur within a workflow
- Who owns or initiates those events and activities
- Decision points and the different paths workflows can take based on their outcomes
- Devices involved in the process
- Timelines of the overall process and each step in the process
- Success and failure rates of the process

Process models are not made manually. Rather, they are produced by data-mining algorithms that use the data contained within event logs to construct models of the workflows as they exist.

As process models are based on quantitative data, they offer genuinely objective views of workflows as they exist in practice, including key data, metrics or events that may have otherwise gone unnoticed. For example, by creating a model of its new account creation process, a software company might discover that a significant number of customers are abandoning the sign-up process because it takes too long. A model could even help the company pinpoint the exact stage at which these drop-offs occur.

Process models are typically rendered using one of two standardized styles of graphical business process notation: Business Process Modeling Notation (BPMN) — also called Business Process Model and Notation — or Unified Modeling Language (UML). Within these notation systems, certain visual elements have universally recognized meanings when used in a process model. Whether an organization uses UML diagrams or BPMN diagrams, these standardized notation methodologies allow process models to be easily shared and read by anyone:

- Arrows represent sequence flows
- Diamonds represent decision points or gateways
- Ovals represent beginnings and endpoints of processes
- Rectangles represent specific activities within a workflow
- Swim lanes are used to identify who owns which components of a process

Business process models should not be confused with process maps, another common type of a business process diagram. Process maps are based on employee reports, they are created manually, and provide higher-level views of workflows. Process models are data-driven deep dives that present more objective views of workflows. [7]

Process models accurately reflect existing workflow inefficiencies, making it easier to identify opportunities for process optimization. Once workflows have been optimized, businesses can use process modeling to standardize workflows across the entire enterprise. The model acts as a template for how processes should play out, ensuring that every team and employee approaches the same process in the same way. This leads to more predictable workflows and outcomes overall.

Process models can take the guesswork out of implementing and evaluating new business processes. By creating a model of a new process, business users can get a real-time look at how that workflow is performing, allowing them to adjust as necessary to achieve process optimization.

Process models can help companies track whether money and resource investments produce suitable returns. For example, by creating a model of the standard sales process, an organization can see how sales representatives are utilizing the tools and systems at their disposal. It may turn out that a certain tool is used much less frequently than anticipated, in which case the organization can choose to disinvest from the tool and spend that money on a solution the sales team actually uses.

Process models transform complex processes into concrete images, making it easier to disseminate and discuss processes throughout the organization. For example, if one department has a particularly efficient process for troubleshooting technical problems, the business can create a model of this process to guide implementation on an organization-wide scale.

2. Related research and methodology

Business process modeling (BPM) in business process management and systems engineering is the activity of representing processes of an enterprise so that the current business processes may be analyzed, improved, and automated. BPM is typically performed by business analysts, who provide expertise in the modeling discipline; by subject matter experts, who have specialized knowledge of the processes being modeled; or, more commonly, by a team comprising both. Alternatively, the process model can be derived directly from events' logs using data mining tools.

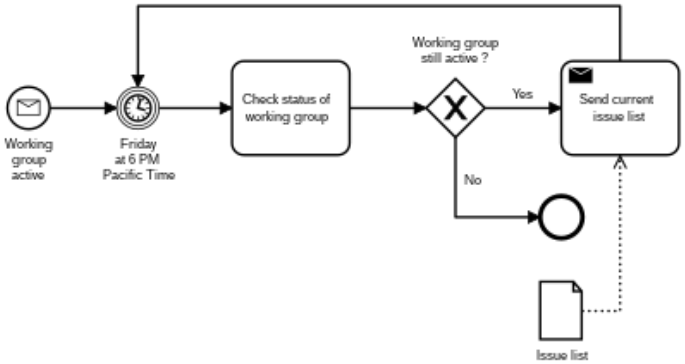

Figure 1. Business process modeling of a process with a normal flow with the Business Process Model and Notation

The business objective is often to increase process speed or reduce cycle time, to increase quality, or to reduce costs, such as labor, materials, scrap, or capital costs as shown on Figure 1. In practice, a management decision to invest in business process modeling is often motivated by the need to document requirements for an information technology project.

Change management programs are typically involved to put any improved business processes into practice. With advances in software design, the vision of BPM models becoming fully executable (and capable of simulations and round-trip engineering) is coming closer to reality.

A business model is a framework for creating economic, social, and/or other forms of value. The term 'business model' is thus used for a broad range of informal and formal descriptions to represent core aspects of a business including purpose, offerings, strategies, infrastructure, organizational structures, trading practices, and operational processes and policies. [7]

In the most basic sense, a business model is a method of doing business by which a company can sustain itself. The business model spells-out how a company makes money by specifying where it is positioned in the value chain.

A business process is a collection of related, structured activities or tasks that produce a specific service or product (serve a particular goal) for a particular customer or customers. There are three main types of business processes:

1. Management processes, that govern the operation of a system. Typical management processes include corporate governance and strategic management.
2. Operational processes, that constitute the core business and create the primary value stream. Typical operational processes are purchasing, manufacturing, marketing, and sales.
3. Supporting processes, that support the core processes. Examples include accounting, recruitment, and technical support.

A business process can be decomposed into several sub-processes, which have their own attributes but also contribute to achieving the goal of the super-process. The analysis of business processes typically includes the mapping of processes and sub-processes down to activity level. A business process model is a model of one or more business processes and defines the ways in which operations are carried out to accomplish the intended objectives of an organization. Such a model remains an abstraction and depends on the intended use of the model. It can describe the workflow or the integration between business processes. It can be constructed in multiple levels.

A workflow is a depiction of a sequence operations, declared as work of a person, a simple or complex mechanism, a group of persons, an organization of staff, or machines. The workflow may be seen as any abstraction of real work, segregated into workshare, work split or other types of ordering. For control purposes, the workflow may be a view of real work under a chosen aspect.

The artifact-centric business process model has emerged as a holistic approach for modeling business processes, as it provides a highly flexible solution to capture operational specifications of business processes. It particularly focuses on describing the data of business processes, known as "artifacts", by characterizing business-relevant data objects, their life cycles, and related services. The artifact-centric process modeling approach fosters the automation of the business operations and supports the flexibility of the workflow enactment and evolution. [3, 6]

3. System and tool technology

Business process modeling tools provide business users with the ability to model their business processes, implement and execute those models, and refine the models based on as-executed data. As a result, business process modeling tools can provide transparency into business processes, as well as centralization of corporate business process models and execution metrics. Modeling tools may also enable collaborate modeling of complex processes by users working in teams, where users can share and simulate models collaboratively. Business process modeling tools should not be confused with business process automation systems - both practices have modeled the process as the same initial step and the difference is that process automation gives you an ‘executable diagram’ and that is drastically different from traditional graphical business process modeling tools.

Modeling and simulation functionality allows for pre-execution "what-if" modeling and simulation. Post-execution optimization is available based on the analysis of actual as-performed metrics.

- Use case diagrams created by Ivar Jacobson, 1992 (integrated in UML)
- Activity diagrams (also adopted by UML)

Some business process modeling techniques are:

- Business Process Model and Notation (BPMN)
- Life-cycle Modeling Language (LML)
- Subject-oriented business process management (S-BPM)
- Cognition enhanced Natural Language Information Analysis Method (CogNIAM)
- Extended Business Modeling Language (xBML)
- Event-driven process chain (EPC)
- ICAM Definition (IDEF0)
- Unified Modeling Language (UML), extensions for business process
- Formalized Administrative Notation (FAN)
- Harbarian Process Modeling (HPM)
- Programming language tools

BPM suite software provides programming interfaces (web services, application program interfaces (APIs)) which allow enterprise applications to be built to leverage the BPM engine. This component is often referenced as the engine of the BPM suite.

Programming languages that are being introduced for BPM include:

- Business Process Execution Language (BPEL),
- Web Services Choreography Description Language (WS-CDL).
- XML Process Definition Language (XPDL),

Some vendor-specific languages:

- Architecture of Integrated Information Systems (ARIS) supports EPC,
- Java Process Definition Language (JPDL),

Other technologies related to business process modeling include model-driven architecture and service-oriented architecture.

Business process modeling arms an enterprise with objective business intelligence that supports more informed decisions for resource allocation, process improvement and overall business strategy. With a clear view of processes, enterprise teams can ensure that workflows always drive the desired results. As a result, operating costs are lower, revenue is higher, and business outcomes are stronger.

Specifically, business process modeling allows companies to do the following:

- Access and utilize quantitative process data: Without a process model, teams are limited to discussing and analyzing workflows in qualitative and subjective terms. As a result, teams may not accurately understand their workflows; they may make business decisions based on misunderstandings, assumptions and/or incomplete knowledge. With process modeling, teams have access to quantitative workflow data, including success rates and error rates, allowing for a more rigorous analysis of business processes.
- Streamline and accelerate process automation: Before a process can be automated, an organization needs a clear understanding of how that process plays out in reality, including the business logic underpinning each decision point. A process model illuminates both the way a workflow unfolds and the relationships between events, actors, tools, and systems within and between processes. This viewpoint helps a team document the process itself and the business rules that guide its execution. This information makes it easier to effectively automate workflows the first time.
- Keep operation costs down: Process models provide organizations with an easy way to identify opportunities to optimize existing processes. This makes it easier for the company to ensure that processes consistently produce the desired outcomes. As a result, business processes require less investment to maintain and generate positive outcomes at a lower cost.

Process modeling forms a cornerstone of any automation effort or business process management initiative. Without comprehensive views of existing processes and their undergirding business logic, enterprises cannot effectively optimize and automate workflows at scale.

System engineering is, very broadly, the work of researching, designing, and managing complex physical or electronic systems over their lifecycles. It focuses on the whole system and typically involves a number of sub-disciplines such as requirements, reliability, logistics, design, testing and maintenance. It considers not only the system itself but also processes, optimization and risk management, and requires sophisticated project management techniques.

In earlier decades, a large but localized team might consider a very specific set of objects within a very specific and controlled environment, to be delivered to a small user base and maintained by perhaps an, again, localized team of experts who each might have a responsibility for only a part of the system. Even for such a controlled and structured scenario, a huge volume of documentation was required to define system requirements, components, engineering process, standards applied and complied with, and the tests to be run on the system. Keeping this documentation cross-referenced, up to date and integrated was a major task.

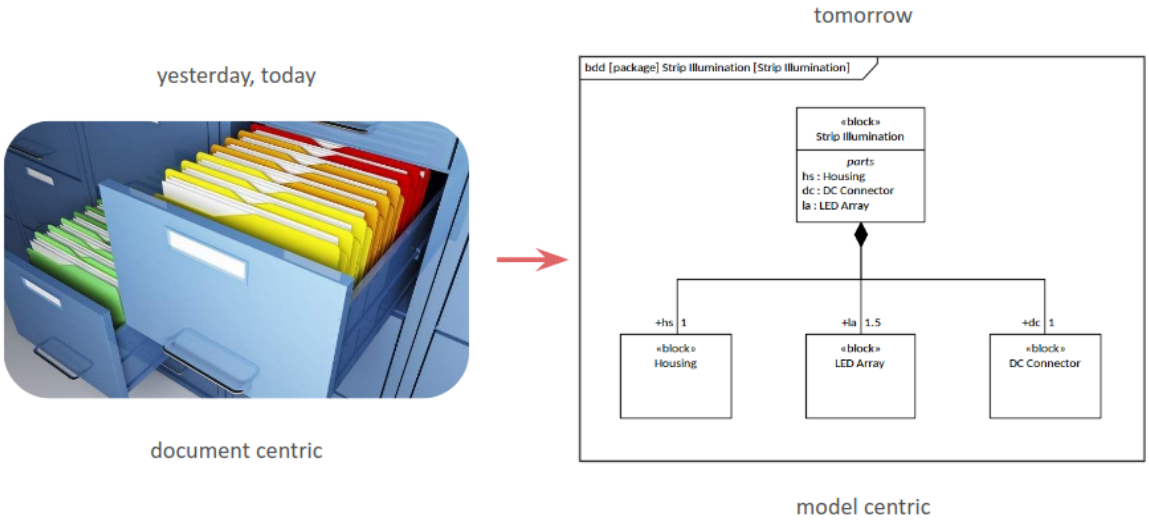

Figure 2. Illustrative model of a Business process modeling of a process with a normal flow with the Business Process Model and Notation

Advancing into computing and basing Systems Engineering work on graphical models (Model Based Systems Engineering) provide huge benefits, allowing engineers to store and retrieve data from repositories, associate data with documentation also held in the repositories, and develop both master structures and variants from templates, all of which reduced the need to recreate and repeat work. The model initially represented the organization of the developing system but grew to reflect the development process and the factors that supported and directed that process, as shown in Figure 2. As computing capabilities grew and more specialized and sophisticated applications were made available, it became possible to represent the components of a system with increasingly varied and detailed model elements, and with increasingly varied and detailed relationships between them.

Engineers could 'load' the model components and relationships with an array of properties, characteristics, and parameters, which could be varied to reflect different scenarios. The standards that the system must apply, or meet could be automatically enforced on the components as constraints, conditions, and rules. More and more of the development process - such as testing - could be represented by element or model features, and more and more aspects of the process could be performed on the model by the application - such as automatic generation of code to make the system operational, and simulation of the system in action under various conditions.

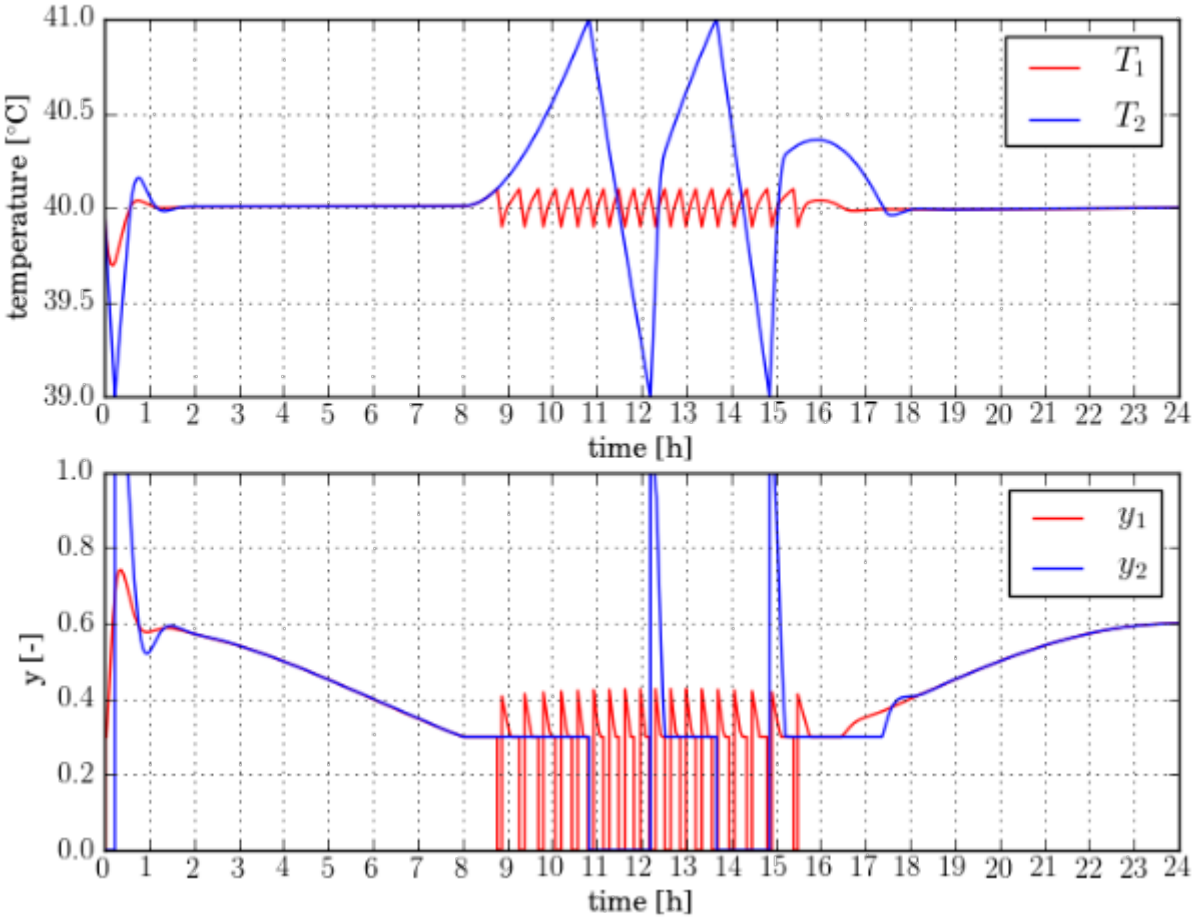

Figure 3. Example of a real time process with a normal flow of activity

Currently, a system engineer is likely to be a member of an interdisciplinary team that has to consider a wide range of factors in architecting, designing and modeling of a system - a much broader, diverse and inexpert user base, a much broader maintenance base, how the system interacts with many other systems, how the system operates in many different and sometimes extreme environments, the impact the system has on the global environment - both within its operating framework and within its pre-use production and final disposal - the socio-economic environment controlling its acceptability and popularity, and how the system compares with its increasing range of competitors. To see how the work of a system engineer has become vastly more complex, one has only to think of a single development, such as the quantum leap from the relatively recent fixed-site landline telephone handset for making voice calls, to the modern mobile smartphone used as a camera, computer, cinema, music center, navigator, and audio, visual and text communicator. [4, 5, 8]

Today, large projects and industries are being developed around systems and products for which the use cases are increasingly complex. Controlling this complexity grows further and further beyond the capacity of an engineer, increasing the level of risk to the product, the end user, and the manufacturer. Examples of systems with dramatically increased risk include the manufacture of passenger air bags to be fitted to many different brands and types of cars manufactured in different parts of the globe; or the requirements for the development of space probes intended to travel to the planets of the solar system and beyond. [1, 2]

There are advances in systems engineering tools and methodologies that have increased the complexity, whilst simultaneously providing the capability to manage and mitigate the associated risk, and reducing the difficulty and effort involved in managing and maintaining highly complex models.

There are advances in systems engineering tools and methodologies that have increased the complexity, whilst simultaneously providing the capability to manage and mitigate the associated risk, and reducing the difficulty and effort involved in managing and maintaining highly complex models.

Systems Engineering (SE) is defined as: “an interdisciplinary approach and means to enable the realization of successful systems”. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem: operations, cost and schedule, performance, training and support, test, manufacturing, and disposal. SE considers both the business and the technical needs of all stakeholders.” So, SE is a junction of three disciplines: engineering, management, and system reasoning. The two main objectives of SE are: 1) the improvement of the current engineering techniques used to create a system-of-interest (SOI), i.e., the final product or service that the organization wants to produce, and 2) the development and improvement of the way of coordination between all the stakeholders that imply the SOI life cycle. These objectives are materialized in standards by two types of processes: management and technical processes. According to these standards, SE deployment in a company consists first of the institutionalization of processes in order to improve its professional activities and results, and second of leading the change so that the processes execution is effective in different projects. Therefore, to succeed in its deployment, we have identified that the company needs to:

- Specify the expectations of the deployed process, of the company itself regarding its current practices, usages, and organization in terms of resources, activities, expected results, and stakeholders having to be involved in the technical or the management process.
- Specify conditions and constraints for success that should be satisfied to start a deployment. This requires a means to assess company’s maturity to face a deployment and a means to assess its interoperability level concerning:
- Conceptual interoperability. The company needs a common language, i.e., a communication basis for all stakeholders involved in the deployment and/or in the processes to deploy. So, concepts, relationships and their semantics have to be specified.
- Technical interoperability. The company needs to share relevant tools supporting the deployment and the execution of the processes to deploy.
- Organizational interoperability. The company needs to identify roles, expectations and usages for the deployment and processes to deploy and define the actors and the business units.
- Identify SE best practices that could be applied in the company, i.e., to specify process models describing what should be pragmatically deployed and how it can be done.
- Be guided in its deployment, i.e., to specify a methodological guide, related and directly applicable in the company, explaining the steps required to deploy SE processes.

The power of process modeling is undeniable for businesses of all sizes and industry verticals.

There are 4 essential attributes that constitute an ideal business process:

1. **Finite** – A good business process has a well-defined starting point and ending point. It also has a finite number of steps.
2. **Repeatable** – A good business process can be run an indefinite number of times.
3. **Creates value** – It ultimately aims at translating creation of value into executable tasks and does not have any step in the process just for the sake of it. In other words, if any step in the process is not adding value, it should not exist.
4. **Flexibility** – It has a built-in nature to be flexible to change and is not rigid. When there is any scope for improvement that is identified, the process allows that change to be absorbed within itself without operationally affecting its stakeholders.

4. Conclusion

Business process automation is a technology-driven strategy to automate a business process in order to accomplish it with minimum cost and in a shorter time. It is extremely useful for both simple and complex business processes. Some areas where business process automation is greatly helpful are:

- Achieving greater efficiency
- Reducing human error
- Adapting to changing business needs
- Clarifying job roles and responsibilities

BPM is a systematic approach to make an organization's processes more efficient and dynamic in order to meet the changing needs of business. Continuous improvement is one of the underlying philosophies of BPM and it aims to put it at the center of all BPM initiatives. BPM is an ongoing approach to continuously make execution of business processes better. Several cloud and on-premises software solutions are available to implement BPM.

BPM solutions are uniquely designed to boost efficiency of processes across verticals and organizations. Implementing them brings a host of business benefits such as: reduction of risks, elimination of redundancies, minimized costs, improved collaboration, agility, higher efficiency, and higher compliance.

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