# The evolution of Project Management (PM): How Agile, Lean and Six Sigma are changing PM

Vittorio Cesarotti, Silvia Gubinelli and Vito Introna
Department of Enterprise Engineering
**"Tor Vergata" University of Rome**
**Rome, Italy**

**Abstract**

*The pressure for speed, technical or design complexity increase interactions and the high complexity of projects. Conventional techniques quickly become inadequate.*

*The literature of the last twenty years about project management (PM), suggests that the evolution of PM Techniques will be driven by theories from Operational Excellence (OE).*

*OE approaches, techniques and tools (like Lean, Agile and Six Sigma ) enrich PM techniques and propose a way to reduce wastes and add value in their project performance culture by encouraging teams to work together in a more transparent and collaborative way. This contamination would make PM techniques be more effective in managing current projects, where the context affects the weight-cost-quality triangle.*

*The aim of this paper is to evaluate the contamination of Lean, Agile and Six Sigma in the traditional approach to project management. This paper presents a brief literature review about the contribution provided by Lean, Agile and Six Sigma to traditional project management and compares them according to general criteria. The innovative contribution is given by the comparison of the project management approach provided by these operational excellence methods and the traditional project management. The main fields highlight how the traditional approaches to PM suggest the steps to carry out, while the techniques acquired by operational excellence (as Lean, Agile and Six Sigma) give suggestions on "how" to perform the steps proposed. The merging of the different techniques, based on the context characteristics, seems a concrete answer to the current problems of the PM.*

**Keywords**: Project Management, Lean Project Management, Agile Project Management, DMAIC

## 1 INTRODUCTION

Literature defines a "project" as a temporary, unique, and progressively elaborated work, undertaking to create a unique product or service. "*Every project has a definite beginning and a definite end, and it is usually divided into phases"* (Rosenau & Gitens, 2005)

The first association to support the Project management dates back to 1965: 'IPMA (International Project Management Association), based in Switzerland. In 1969 was founded the PMI (Project Management Institute); currently, his guide to the PM, the PMBOK (Project Management Body of Knowledge), is an ANSI standard and the document that underlies the new standard ISO 21500 on Project Management. In 1989 the British Government developed for the management of information technology projects the PRINCE2 (Projects in Controlled Environments), the standard currently widespread in all countries of Anglo-Saxon origin.

The frameworks promoted by these institutes form the basis of the traditional PM.

Nowadays the PMI (Project Management Institute) is the most widespread association, (Farashah, JaniceThomas, & Blomquist, 2019). In the rest of the paper, we will refer to the PMBOK as a symbol of the classical project management framework.

Although classical approaches have been revised over the years, the change in the context of reference has been sudden and radical. Today, classical project management approaches have proven to be inefficient. (Rebaiaia & Vieira, 2014)

*Projects are considered successful if the CSC disposals (Content, Schedule, and Cost) remains low and to cope with the growing uncertainty of context Project management need to provide a basis for real control and predictable outcomes* (Koskela G. A., 2000). Most of the real-word development effort is conducted in volatile environments. Nowadays organizations need to adapt to changing technology, markets, and social conditions. Project management approached based on the traditional predictive lifecycle development methodologies mismatch with such a dynamic system.

*"Elaborate methodologies, tools, and practices have evolved to manage on out-of-control-world. Traditional tools fail when linear tasks do not easily accommodate dynamic processes and when schedules require frequent updating to reflect changing circumstances. Skilled professionals do not adapt well to micromanagement, and tools and techniques quickly reach their limits when not used appropriately. Managers realize that increased control does not yield increased order, excepting their own inability to know everything in advance while relinquishing some control to achieve greater order*." (Agustine, Payne, & Sencindiver, 2005)

The need to set aside old management techniques to establish effective governance of the project and build internal capabilities to track and monitor the Progress project emerged. One response to these problems was found in the adoption of operational excellence techniques, such as Lean and Agile. Since the late nineties, the concepts of Lean project management and Agile Project management have been widespread and consolidated. In practice, however, few companies are able to adopt these approaches successfully and despite the heaviness of the old methods, they feel safer with them and use to prefer them. By the way, many authors propose integrating PMBOK guidelines with Lean and Agile methodologies into a toolkit. Rebaiaia and Vieira underline how these techniques "*provide a way to excellence in terms of feasibility and create more flexibility in the realization of projects*". (Rebaiaia & Vieira, 2014)

This research compares the different approaches to the PM according to general criteria.). To identify the criteria with respect to which to carry out the comparative analysis of the different approaches we analyzed existent literature. We carried out an analysis of the literature concerning both articles describing the individual methodologies and articles that compare one or more of them. From this analysis, we collected the main characteristics on which the authors in the literature evaluate the methods. It's important to note that existent literature provides the only comparison between Agile and Traditional PM, Lean and Traditional PM. About Six Sigma, Literature presents an only analysis of the PM approach in the Six Sigma Project. Instead, this paper provides a joint comparative analysis of all the PM frameworks provided by Lean, Agile, Six Sigma and Traditional approaches.

In the following section, a description of Traditional, Agile, Lean and Six Sigma approach to PM is given. In paragraph three the steps of the methodology that led to the definition of the comparison criteria are described and a description of the criteria is provided. in paragraph four we presented the comparison of the methods. After that, you can find the conclusions, where reflections about the possibility to merge the techniques and suggest future areas of investigation are given.

## 2 PROJECT MANAGEMENT APPROACH

A project manager has different ways to approach a project (Messemaeker, 2010). Over the past 60 years of project management research, several methodologies have been developed from an academic or practitioners' background, but only a few have made it to internationally-recognized standards (Turner, 2010). Internationally recognized methodologies as PRINCE2 (Projects in Controlled Environments) and framework as PMBOK (Project Management Body

of Knowledge) provides flexible tools that can be easily adapted to specific needs (McHugh & Hogan, 2010).

As Iivari, Hirschheim, & Klein, (2000), in this paper we use the term "Project management approach" to identify the set of principles and guidelines that define how specific project is managed; and "project management framework" to represent operative set of rules, processes, methods, and templates to be used during the project lifecycle (Iivari, Hirschheim, & Klein, 2000).

Sometimes standard methodology and the organization mismatch, so many organizations tailor existing methodology or create their own method (McHugh & Hogan, 2010) (Garcia, 2005). As McHugh & Hogan said, companies are moving away from internally developed to more broadly recognized methodologies (McHugh & Hogan, 2010).

## 2.1 TRADITIONAL PROJECT MANAGEMENT

Project Management Institute (PMI) defined Project management methodology as a set of methods, techniques, procedures, rules, templates, and best practices used on a project (Project Management Institute, 2008). These guidelines define how a specific project is managed. As Spundak said, *"Other definitions do not differ significantly"*. (Špundak, 2014). For more definitions, we suggest (Špundak, 2014.).

The PM was formalized with the first versions of bodies of knowledge in the 1980s. At this time, the projects were intended as relatively simple, predictable and linear with clearly defined boundaries. This believing constitutes the Traditional PM (TPM) approach, in which the activities are considered easy to plan in detail and teams can follow the plan defined in at the beginning of the project without many changes. The main goal of TPM is the optimization of cost and time of the activity initially detailed in the project plan and consequently, finalize Project within planned time, budget, and scope. For more information about this, we recommend (Špundak, 2014) and (Masciadra, 2017).

PMBOK is a framework internationally recognized, given by PMI. That provides the fundamentals of project management, regardless of the type of project. The first edition of PMBOK, published in 1996, was a collection of processes and knowledge areas generally accepted as best practice within the project management discipline.

PMBOK describes a process in terms of Inputs (documents, plans, designs, etc.), Tools and Techniques (mechanisms applied to inputs), and Outputs (documents, products, etc.) and provides comprehensive guidance for who apply it. It recognizes five basic process groups and ten knowledge areas identifies as typical of all projects. The five basic process groups are:

1. Initiating: defines and authorizes the project (project charter creation).
2. Planning: define the outcomes/goals for the project by knowledge area.
3. Executing: project plans implementation.
4. Controlling and Monitoring: assesses defined outcomes to planned targets and if necessary set corrective actions.
5. Closing: structured Process for obtaining the formal acceptance of the product/service from the stakeholders

The ten knowledge areas are Integration, Scope, Schedule, Cost, Quality, Human Resource, Communications, Risk, Stakeholders, and Procurement. (Mirzaei & Mabin, 2012) (Project Management Institute, Inc., 2017)

The traditional approach is more appropriate for projects with clear requirements and objectives for initial users. By not providing for the involvement of end-users, this approach is appropriate in case of a low variation of requirements. The traditional approach is also appropriate for projects where formal documentation is required and is highly valued in the operational routine projects, which take place in a predictable way and it is easy to verify the outputs. It is also noted that for larger projects, intended as the number of project team members or the amount and complexity of clearly defined requirements, or even for durability, the traditional approach is more appropriate (Špundak, 2014).

Over the years, it has been updated coming up to the sixth edition, incorporating in its framework agile approaches (Lifecycles and techniques) and some Six Sigma tools.

The last edition of PMBOK includes a paragraph dedicated to new trends in PM processes, such as approaches and tools from the agile field. This "testifies" the will of the world of PM to integrate new knowledge within his body.

## 2.2 AGILE PROJECT MANAGEMENT

The term Agile PM (APM) born in 2001 when the "Agile Manifesto" was published. It refers to a set of approaches and instruments (e.g. SCRUM, Extreme Programming, DSDM, etc.) that have been developed with particular reference to the management of software development projects (Highsmith, 2001)

In their 2001 manifesto, Fowler and Highsmith describe values and principles that should drive a project and stress the importance of adopting an incremental or iterative style of software development. (Messemaeker, 2009-2010). About this, please see (Highsmith, 2001). APM embodies the majority of today's methodologies, like Extreme Programming, Crystal Methodologies, Scrum, Adaptive Software Development, Feature-Driven Development, Dynamic Systems Development Methodology and others (Messemaeker, 2009-2010).

These methods differ in specific techniques but have in common: short iterative lifecycles, frequent relations with customers, and constant learning. Among them, Scrum and XP are the most widely adopted (Elahe & Mahmud, 2014). About Scrum method, we suggest (Permana, 2015) (Fowler, 2018). About XP, we suggest (Beck & Fowler, 2000).

A project that employs agile methodologies is complex adaptive systems (CAS). The CAS-based Agile Project Management (APM) framework prescribes the six practices for managing agile development projects: Guiding vision, Agile vigilance, Organic self-organized team, simple rules, open information and adaptive leadership (Agustine, Payne, & Sencindiver, 2005):

- Guiding vision. Described by Agustine, Payne, & Sencindiver (2005) as follow "*Ensure a shared guiding vision for all team members.[…] Recognizing and nurturing a shared project vision as an internal model translates it into a powerful influence on team behavior."* (Agustine, Payne, & Sencindiver, 2005)
- Organic self-organized team from 7 to 9 members: Small and dynamic team composition supports adaptability to changing external conditions. The optimal internal communication allows the team to minimize the effect of an interaction penalty (Agustine, Payne, & Sencindiver, 2005). Scrum's formalism recognizes three key roles: Product owner, development team and Scrum Master. The product owner represents the stakeholders and ensures that the team offers value to the business. The Development team is responsible for the practical advancement of the project. The Scrum Master acts to support the team in applying the Scrum methodology and prevents external influences from reducing the effectiveness of the team. (Darwish & Muhammad, 2017)
- Define simple rules to develop projects: XP practices provide simple and generative rules. If some practices are not being followed, the team analyses and remove the causes. In this way, the rules become easily implementable and do no restrict the autonomy and creativity of team members

- Open and free-flowing information between team members. The single element of the team is enriched by the group's knowledge
- Adaptive Leadership: The excessive presence of structure stiffens the internal dynamics of the team; on the contrary, the lack of structure throws the systems into chaos. Adaptive leadership promotes the creation of an adaptable and evolving Team process able to adapt to different contexts. Collaboration and communication are central aspects and allow teams to move faster by solving things face to face. The customer is part of the team and continuous communication with him allows changing the goal of the project is running (Rebaiaia & Vieira, 2014).
- Agile vigilance: In a context constantly changing, the agile manager must adapt the project on the edge. Without a rigid project structure, supervision takes on a central role to balance, chaos, risk and project boundaries. (Agustine, Payne, & Sencindiver, 2005)

The agile manager understands the effects of the mutual interactions among a project's various parts and steers them in the direction of continuous learning and adaption. Adaptive APM-based framework includes several practices, like adaptability; fluid organizations, recognition of external control limits in task prioritization and the focus of problem-solving techniques in which the individual plays a central role. All members are skilled and valuable stakeholders in team management. The main troubleshooting mechanism is the team's self-regulating ability that allows also minimizing up-front planning and stressing instead adaptability to changing conditions.

As explicitly described in the 2001 manifesto, the agile PM was created for the software world. In the literature, there are several successful cases concerning the application of the APM to small projects, in which the collaboration of the team members is facilitated by the possibility to relate in person. (Paasivaara, Durasiewicz, & Lassenius, 2008) The central role of interpersonal communication in Agile methods leads them to can not be simply used in Global software development (GSD) (Lee & Young, 2010) (Fraser & Mancl, 2019). To get benefits of Agile in GSD and in a distributed project, PM developed distributed versions of agile methods called, distributed agile development (DAD). Most used are distributed Scrum (DS) and Distributed XP (DXP). (Paasivaara, Durasiewicz, & Lassenius, 2008)

Passivaara highlight that literature lack of advice for large projects but "*it seems that quite many companies are interested in taking (DAD) into use, or have already started to use it."*

In particular, Lee & Young (2010), highlight successful practices and challenges that have been overcome by the globalization project and suggest a framework for software globalization project management using a distributed Agile approach (Lee & Young, 2010). "*Nevertheless, advice on pairing agile software development and GSD, also referred to as is scarce. There are only a few reported experiences in applying DAD to industrial projects."* (Paasivaara, Durasiewicz, & Lassenius, 2008)

## 2.3 LEAN PROJECT MANAGEMENT

The first definition of LPM is given already in 1997; over the years, Lean has focused on the concept of value within the projects. The Lean philosophy is therefore seen as a complementary element to the existing PM techniques, which focuses on eliminating waste and creating the value (Cruz-Villazon, 2018). Reuch defines lean as an engine for innovation in PM standards (Reusch, 2013).

The management of a project is said "Lean " when the systems are structured to deliver the product, maximizing the value and minimizing waste. The management of Lean projects differs from traditional project management in the objectives pursued, in the structure of its phases, in the relationship between the phases and the participants at each stage.

Lean methods reorganize the common structure of knowledge in PM and focus on relationships, shared knowledge, and common goals. The main results consist of significant improvements in schedule and waste (time and resources) reduction. The greatest results stand on complex, uncertain and quick projects (Ballard & Howell, 2003).

Lean philosophy finds its first applications in production systems. Similarly, the projects concerning production systems first adopted LPM. As shown by Cruz-Villazon most of the documented application of LPM is in the field of Construction (60%), 25% is about general type of project, 10% in software projects and the remaining part in healthcare (3%), mining (1%) and aerospace projects (1%) (Cruz-Villazon, 2018).

Lauri Koskela (1992) first alerted the construction industry to the revolution in manufacturing, challenging it to explore and adopt these new concepts and techniques under the name "Lean Construction". In 1993, he hosted the first conference of the International Group for Lean Construction (IGLC). The IGLC, as said by themselves, is *"dedicated to the development of a theory of production and production management, with the project as the most fundamental system for designing and making things*".

Koskela intends the project as a system of temporary production supplied in terms of materials, information and resources from multiple and durable production systems. Every production system integrates the design and the realization of a product. The project, like the Management of production, is understood in terms of design, operation, and improvement of production systems. The operation is about planning, control, and correction. The correction may entail the change of the means used or the objective pursued. (Koskela, Ballard, Howell, & Tommelein, 2002)

### 2.3.1 LEAN PROJECT DELIVERY SYSTEM (LPDS)

In the field of project-based production systems and their management, the Lean Production Delivery System (LPDS) gives tools and roles.

Production Systems recognize three fundamental goals: Deliver product, Maximize value and Minimize waste (Koskela G. A., 2000). Consequently, principles for production system design include Structure work for value generation; Understand, analyze and expand customer purposes; Increase system control (ability to realize purpose). (Ballard et al. 2001). Lean's production system focus translates into LPDS's goals on transformation, flow, and value. "*Downstream player is involved in upstream decisions and stakeholders interest are aligned, that allows to perform the activities at the last responsible moment. All the product life cycle stages are considered in design and buffer are sized and located to absorb system variability. Learning activities are an integral part of the project"* (Ballard & Howell, 2003)**.**

Traditionally, Projects have been understood in terms of phases. Some of the key differences between traditional and lean project delivery concerns the definition of phases, the relationship between phases and the participants in each phase. The phases of LPDS are:

1. Project definition.
2. Lean Design
3. Lean Supply
4. Lean Assembly

(Rebaiaia & Vieira, 2014)

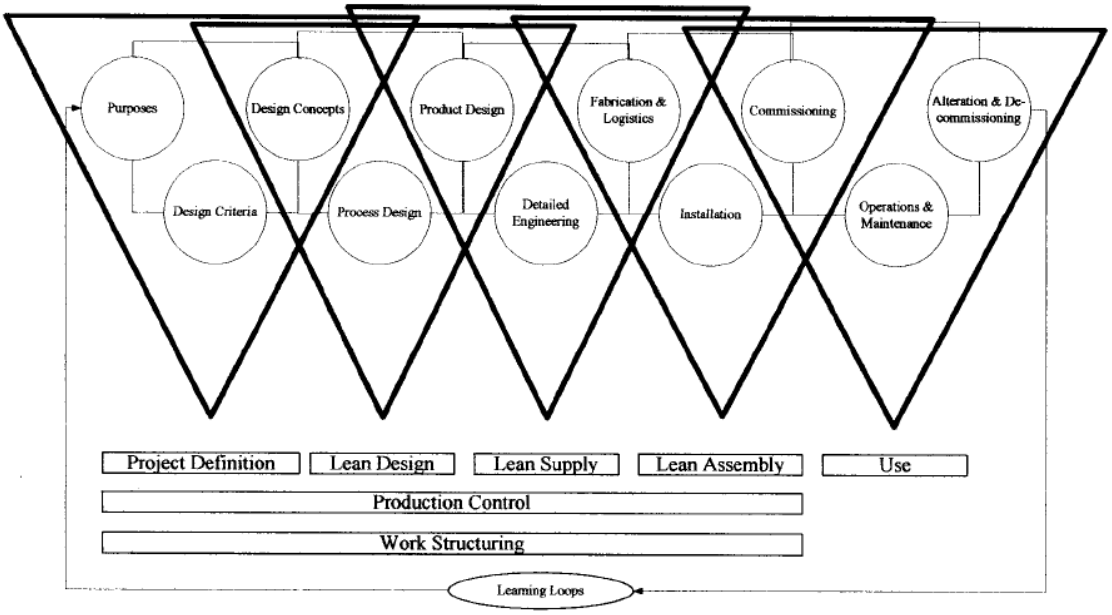


Figure 1: Triads of the LPDS (Ballard & Howell, 2003)

PROJECT DEFINITION. In this phase, the project is represented as a process of aligning Ends, Means, and Constraints (location, cost, time). Through a conversation with Customers and stakeholders, the team achieves purposes and values, design concepts, and design criteria. (Rebaiaia & Vieira, 2014) (Ballars, 2008). Project definition develops through sequential phases: starts with business planning proceeds to business plan validation if the initial plan appears to be feasible, and ends with a decision by the client to fund or not fund a project.

Agreeing with the definition of the project with the customer does not seem to be a common practice. The experienced PM's often complain that customers start dictating means rather than revealing the purpose, and rarely reveal what they are willing to spend to get their purposes. AEC Professionals (Architects, engineers, and builders) are usually asked to provide the means required by customers, without having any role in the customer's purpose and value specification. Citing Ballars *"In the Lean project delivery system, it is assumed that the project delivery team's work is not just to provide what the customer wants, but to first help the customer decide what they want"*. In LPDS, the team exposes to customers alternative means to accomplish their own goals in addition to those previously taken into account and helps them to understand the consequences of their Desires. This process inevitably changes all variables: end, means, and constraints (Ballars, 2008).

LEAN DESIGN. The gate between Project Definition and Lean Design is the alignment of values, concepts, and criteria. Stakeholders dedicate the interactions to developing and aligning product and process design at the level of functional systems. A project can return to the project definition if the continuous research of value reveals opportunities consistent with the constraints of customers and stakeholders.

The Lean design differs from traditional practice by adopting the "set-based" strategy, in which the interdependent specialist has freedom of action within the limits of the set of alternatives currently under consideration. On the contrary, traditional practices involve the initial selection of activities and become ineffective when there is no alignment between the team members. In this way, the paradigm goes from "carry out the activity as soon as possible" to "make decisions within the lean time for the realization of alternatives."

LEAN SUPPLY. It consists of detailed engineering, fabrication, and delivery. It includes also initiatives as reducing the lead time for information and materials, especially those involved in the supply of engineered-to-order products, which typically determine the pace and timing of project delivery. Prerequisites are a product and process design.

LEAN ASSEMBLY. It begins with the delivery of material and the relevant information for their installation. The systematic use of feedback loops between supplier and customer processes is symbolized by the inclusion of Post-occupancy evaluations between projects to get a full description of the implementation of LPDS we recommend (Ballars, 2008).

As with other approaches to the PM, even in the LPDS the management of costs and risks plays a key role. About cost management, LPDS introduces within the phases the Target Costing, a method "*for modeling product and process design to deliver customer value within constraints"* (Ballars, 2008). This method is the application to the projects of the Improvement Cycle (IC), a production-oriented business management philosophy that self-imposes the necessity as an engine of continuous improvement and innovation. Process improvement is achieved by reducing variation through experiments (intended as a deviation from standards) and by acting on the root causes of breakdowns (Ballars, 2008).

The risk is managed through buffers dimensioned to perform their functions within the system, primarily against variability. The job of buffers is to absorb variation. One variation is reduced, the next step is to match buffers to actual variation. Lacking the ability to act at the level of the entire production system, the traditional approach must build buffers against the variability and

risk at the beginning of the project. Buffers can take the form of information, drawings, materials, work in progress, space or time (Ballard & Howell, 2003)

## 2.4 SIX SIGMA (SS)

Six Sigma is a data-driven methodology for improving products, processes, focalized on the elimination of defects. Jainendrakumar referring to 3th edition of PMBOK said "*PMBOK applies Six Sigma data-Driven Techniques, Improved Scope Management, Improved Quality Planning and Control; Large Project Orientation Focused on Coordination and Management (in addition to Results), Management and Control Methods lays Foundation for Planning, Organizing, Managing, and Controlling Projects. Some of the Quality Control Tools and Techniques used in PMBOK are also used in Six Sigma.*[…] *Six Sigma as Systematic Data-Driven Methods Incorporate PM Concepts and uses PMBOK Planning, Organizing, Managing, and Controlling Methodologies*" (Jainendrakumar, 2008).

The six sigma projects are usually implemented to fix an existing product or process that don't meet customer specification or the performance required by the company. Six Sigma method can be also applied for the design of new products or services; in this case, it is called. Design for six sigma. Both the application of six sigma are implemented by phases.

Six Sigma projects develop through the DMAIC framework. DMAIC is the acronym for the main phases of the six sigma project: Define, Measure, Analyse, Improve, Control.

In the DEFINE phase team is formed, the leader and customer set context and objective of the effort. Project charter, CTQs and Business process maps are the main deliverables. Identified the customer requirements and project boundaries, in the MEASURE phase team identify key measures and implement data collection activities. The collected data are analyzed in the ANALYZE phase. In this phase, statistic tools are implemented. In the IMPROVE phase, the team shows the results of the Analyze step to stakeholders involved in the process to modify. In this phase, Team and Stakeholder generate and validate possible solutions. In the last phase, CONTROL, Team define plans and procedures to ensure sustained improvements (Jainendrakumar, 2008). Throughout all the stages of Six Sigma, effective communication plays a central role. A communication plan is undoubtedly important to highline responsibilities and escalation rules. The Team Leader, usually a Six Sigma Black Belts or Six Sigma Green Belt, needs to recognize the stages of team development and choose targeted approaches for optimizing performance at each stage.

This framework is also used for Lean Six Sigma (LSS) projects. LSS is a methodology that integrates Six Sigma and Lean using DMAIC cycle as a conjoint continuous improvement framework (Tenera & Carnero Pinto, 2014). DFSS approach still lacks a single methodology (Hoerl, 2004). For the DFSS project implementations, there are several methodologies and is not a better approach at all. In literature, the most used approach is DMADV(define measure, analyze, design, verify), IDOV (identify, design, optimize, verify), and DIDOV (Define, identify, design, optimize, verify). (Patil, Andhale, & Paul, February 2013). (Asad, 2006)

In this search, for simplicity, we will talk about the SS methodology referring only to the DMAIC. It is worth noting; that in this research what we refer to DMAIC can also be reported for the DFSS frameworks and to LSS projects.

Both SS and PMBOK require project charter, milestones, a stakeholder management system and a cost-resource-schedule management system. Even Jainendrakumar (2008) stand: "*Six Sigma has a solid control phase (DMAIC: Define-Measure-Analyze-Improve-Control) that makes specific measurements, identifies specific problems, and provides specific solutions that can be measured[…] Six Sigma – strongly concentrated on preventing defects instead of attempting to detect them after they occur. PMBOK also suggests prevention is better than repair."* (Jainendrakumar, 2008). The sixth edition of PMBOK introduces SS and LSS as quality improving method. (Project Management Institute, Inc., 2017).

## 3 COMPARISON AND DISCUSSION

### 3.1 METHODOLOGY

For the comparative analysis of the different approaches the main steps taken were:

1. Literature review
2. Characteristic identification
3. Comparative analysis

The literature review was carried out by selecting paper from ScienceDirect, Scopus, IEEE, Google Scholar. The keyword for the selection was: Lean and Agile Project Management, Lean Project Management, Agile Project Management, Six Sigma and Project Management, Traditional Project Management, Comparative analysis.

By reading the title of the papers, only the papers describing the methodologies and a comparative analysis of them were selected.

Of the selected articles, by the reading the abstracts allowed us to make a further selection.

On the basis of the selected literature, through the full reading of the articles, we collected the characteristics according to which the methodologies and criteria presented in the comparative analyses are described, and consequently, we defined the comparison criteria.

Referring to the selected literature, a comparative analysis was carried out. For the sake of brevity, in order not to deviate the focus from what is the integrated analysis of the methodologies, only the sources considered most representatives for the purposes of the conclusions drawn were reported in this research.

In this paragraph, the different techniques are compared in regard to the criteria, which represent the main aspects of project management.

- Project management structure: Approach, team Dimension, Internal communication, Leadership style
- Stakeholder policy, focusing on the role of customer
- Main boundaries: Time, Risk &Cost through control delivery, rework, cost, risk
- Main application

## 3.2 PERSPECTIVE VS. ITERATIVE APPROACH

The analysis of the operating modes of LPM, APM, SS, and PMBOK allows identifying two different approaches to process management: the prescriptive approach and the iterative (or time-boxing) approach.

The "prescriptive" approach involves the definition of tasks to perform sequentially. This task defines the life cycle of a project, structured as a sequence of phases in prescriptive. The role of the Project manager focalizes on timekeeping of the activity due to the defined sequence. The rigid definition of activities in the sequential "prescriptive" approach, leads to privileges in the prevention of changes in the project and the deliverables. The planning and estimation of costs and times are a consequence of the specifications of the deliverables. This structure characterizes traditional PM and Six Sigma PM approach.

Instead, the iterative logic is to get to produce as quickly as possible the deliverables and then finish them through successive cycles of improvement. The requirements and solutions mature in the course of work through the collaboration of the development team with the client.

This approach focuses on contractual times and costs and handles them with a Timeboxing logic. In this way, it adapts the design scope according to the small development speed. This guarantees the flexibility of the project and consequently the maximization of the value delivered in the agreed time and costs. The requirements and solutions mature in the course of work through the collaboration of the development team with the client. During the development of the project, the team collects and manages any change needs within new releases or product versions. (Beck et all., 2001). The iterative and evolutionary approach in project management characterizes Agile and Lean methodologies.

Within these approaches, the processes of defining the scope, WBS creation, and scope verification are iteratively repeated according to customer specifications.

It lends itself very well to manage projects such as software development or research or engineering phases.

Table 1: Strengths and Weaknesses of the Perspective and Iterative approaches (Adapted From HumanWare, 2019 )

| Approach | Strengths | Weaknesses |
|---|---|---|
| Prescriptive Approach. | • The definition of a rigid sequence of activities, already in the initial phases, simplifies the role of the project manager, who plays the role of timekeeper;<br>• Defined and formalized requirements and documentation;<br>• Accurate initial risk analysis and preventive activities;<br>• The level of formalization does not require staff highly skilled;<br>• The schedule plan of each phase allows easy monitoring and control. | • Inflexible deliverables;<br>• Planning and analyze activity is time expensive and can delay the implementation;<br>• "*Once formalized, the requirements can only be modified through specific escalation procedures*" (HumanWare, 2019);<br>• The customer is involved only in the final evaluation of the product. |
| Iterative Approach | • Hight flexibility;<br>• Rapid initialization and incremental development;<br>• New requirements and changes are managed quickly;<br>• Active collaboration whit customer in the development<br>• Frequent test and revision times of the requirements. | • Difficult assessment of risks and project costs in the early stages;<br>• The lack of formal documentation can lead to misconceptions into the team and can create problems of use by the project manager or by the user or government |

| | | |
|---|---|---|
| | | • Requires highly qualified customer staff;<br>• Time expensive for the customer. A continuous involvement is required;<br>• "*The horizon is focused on the short term is there is, therefore, the risk that the long term perspective will be lost"* (HumanWare, 2019) |

(HumanWare, 2019)

It is worth noting, that the two approaches are not mutually exclusive. (HumanWare, 2019). In adopting the agile approach, It is recognized as an error abandoning the areas of knowledge and project management processes as described in the PMBOK standard (Project Management Institute, 2009).

The latest version of PMBOK reports different approaches to the project life cycle (both predictive and other). An iterative approach such as Agile or Scrum can be applied where this is compatible with the release of the corresponding deliverables and with the objectives of the project. (Project Management Institute, Inc., 2017) (HumanWare, 2019)

When the requirements are well defined and documented, an entirely "prescriptive" approach is preferable. In the case of changing needs and specifications it is preferable to adopt iterative approaches but within a system of the overall governance of the project structured according to the expected by PMBOK (HumanWare, 2019)

## 3.3 TEAM DIMENSION, INTERNAL COMMUNICATION AND LEADERSHIP STYLE

The analysis of the strengths and weaknesses of the different approaches highlights how the different approaches require the project team's different features. In the prescriptive structure, the team does not need a deep knowledge of the dynamics of Project management. The activities are organized by the PM according to the downstream planning. According to PMBOK "the project management team is responsible for determining what is appropriate for any given project" (Jainendrakumar, 2008). The management of large project groups is facilitated by the unpacking of the activities. On the contrary, the adoption of the iterative approach brings with it the centrality of the feedback. Both Lean and Agile focus on people, on inspecting and adapting in order to improve the work-product and efficiency in producing it. As Rebaiaia and Vieira (2014) stated, *"feedback is critical–from people, from customers, from stakeholders, and*

*from the product itself"* (Rebaiaia & Vieira, 2014). To be able to effectively manage the team members, they need to be aware of the project management dynamics. Agile techniques explicitly define the roles to administer within the project. According to with APM, SS is implemented through the small team (typically 4-5) and Champions, Master Black Belts, and Green belts, usually the role of the project manager is in the head of GB (Zhang, Ifran, Khattak, Zhu, & Hassan, 2012).

### 3.4 STAKEHOLDER POLICY AND ROLE OF CUSTOMER

In the traditional approach, stakeholders and customers define the scope, budget, and boundaries of the project. The team can only move and optimize the performance of the process moving inside the boundaries dictated in the early stages of the project. The agile manager understands the effects of the mutual interactions among a project's various parts and steers them in the direction of continuous learning and adaption. Contrarily to the linear PM approach, in which the team dimension depends on goal and budget, in APM the team is small and dynamic. This team composition supports adaptability to changing external conditions. Scrum's formalism recognizes three key roles: Product owner, development team and Scrum Master. The team also requires continuous feedback to the customer and no prevision is made in the early stages. Also in LPM, the customer takes part in project development. Indeed, a downstream player is involved in upstream decisions and stakeholders interest are aligned, that allows performing the activities at the last responsible moment.

Compared to the above methodologies, Six Sigma involves the customer both in the initial phases and in the validation of the intermediate deliverables. In the Define phase, the client is involved in the creation of the project charter. In the course of the project, the team involves stakeholders based on the process issues they need to solve. Leadership has been identified as a critical success factor for Lean Six Sigma deployment in organizations. As said by Laureani & Antony (2015) SS projects are "*a transformational journey for an organization and they radically change the way things are done; it is necessary for the leader to be visibly at the forefront of this journey, personally leading the charge and being identified with it. It is not only the top executive leaders: ensuring top-performing people in all business units and geographies are engaged in the programme is key to achieving visibility*." About this please see (Buti Al Shamsi, 2013) (Laureani & Antony, 2015).

### 3.5 TIME, RISK AND COST: THROUGH CONTROL DELIVERY AND REWORK

The two approaches can also be analyzed through the costs of the overall project planning and the management of project changes.

In the case of a traditional approach, the cost of project planning depends on the stages of the project. In the early stages, are consistent and then, when an organization acquired certainty tends to decrease. In the iterative approach, they remain sustained until at the end, because the succession of versions and releases obliges to a continuous revision of the initial objectives. In the case of configuration management and modifications, the traditional approach responds to the introduction of changes to the project specifications increasing costs, in particular in the implementation phase, while tending to stabilize. Otherwise, the iterative approach incentives the changes, this could increase the rework resulting in increased times and costs. The lean approach to avoid this problem introduces the target costing in every gate of the project (Ballars, 2008).

The differences between the structures of the two approaches inevitably imply different risk management. The concept of risk is closely related to the management of the unexpected. Therefore, control activities, and consequentially rework, assume a central role.

In the prescriptive approach, the risks are target costing of the project and the changes in the project objective are not contemplated. According to SS, which is strongly concentrated on preventing defects instead of attempting to detect them after they occur, “also PMBOK also suggests prevention is better than repair.” (Jainendrakumar, 2008). Contrary to what happens in the traditional approach, in Lean (and in Six Sigma approach too) control is an iterative activity accompanying all phases of the project. The purpose of the control, in this case, is to identify the reasons for non-completion and to define the actions to prevent a recurrence. As a result, planning under Lean is the gradual reduction of uncertainty to reduce the presence of unanticipated constraints (Koskela, 2000). Six Sigma implement both initial and iterative approach of control. In LPM and APM, adaptability is the key characteristic, even more, important than predictability, states (DeCarlo, 2004). In fact, LPM manages risks using buffers to absorb variation. Buffers can take the form of information, drawings, materials, work in progress, space or time. The team iteratively reduces variation and matches buffers to actual variation through learning activities. The continuous rework and buffer sizing, allows team members to perform the activities at the last responsible moment. By cons, Agile methods do not suggest specific activities to manage risks and only Scrum and XP have

activities to control impediments. Agile Methods reduce risks through multiple iterations (Sprint) and continuous feedback.

Otherwise, the traditional approach, sixes the risk only at the beginning of the project. For these reasons, it is good that the overall governance modalities of a project remain structured according to the "Prescriptive" logic and only a few phases are managed with iterative development or prototypes. (HumanWare, 2019)

### 3.6 MAIN APPLICATION

Traditional PM is typically implemented in projects that include operational routine projects in a predictable way and verified how to accomplish the project's objectives, such as typical construction or engineering projects (Špundak, 2014).

Otherwise, the main fields of application of the LPM are of the construction field, which constitutes a consolidated branch of the PM. As described by Cruz-Villazon, other applications can be found in the general field of business projects, software development, healthcare, mining and aerospace (Cruz-Villazon, 2018).

About APM, the main application would be a small software development project, most often within a single organization. Since the last decade, companies have begun to implement agile techniques even for large global projects (Paasivaara, Durasiewicz, & Lassenius, 2008).

Six sigma has been first applied in manufacturing. In recent years, it was applied also in the finance sector, typically for improving the accuracy of allocation of cash to reduce bank charges, automatic payments, improving the accuracy of reporting, reducing documentary credits defects, reducing check collection defects, and reducing variation in collector performance. Other applications are in the engineering, construction, and healthcare sector. As noted by Sharma, Bhardwaj, and Kumar "*Six sigma principles and the healthcare sector are very well matched because of the healthcare nature of zero tolerance for mistakes and potential for reducing medical errors. Some of the successfully implemented six sigma projects include improving timely and accurate claims reimbursement, streamlining the process of healthcare delivery, and reducing the inventory of surgical equipment and related costs* (Sharma, Bhardwaj, & Kumar, 2010). About other implementation areas of SS and Lean Six Sigma, please see (Zhang, Ifran, Khattak, Zhu, & Hassan, 2012)

Table 2: PM Approach comparison

| Topic of analysis | Traditional | Agile | Lean | Six sigma |
|---|---|---|---|---|
| Lifecycle Approach | Prescriptive | Timeboxing | Timeboxing | Prescriptive |
| Team dimension | Varies, depending on the project | Small and dynamic team | Small and dynamic team | Small team. |
| Internal communication | Fragmented Information. | Free open access to information | Free open access to information | Free open access to information |
| Leadership style | PM as coordinator. Internal conflicts managed by escalation. | Adaptive leadership | Adaptive leadership | Conductive leadership |
| Role of customer and stakeholder policies | Customer define project goal, budget and time in the early stages of the project. | Continuous feedback from the customer. Stakeholder interest are aligned | Customer is involved in project development. Downstream player is involved in upstream decisions and stakeholders interest are aligned | Customer is involved in Define and Control stages. Stakeholders contribute to the solution creation |
| Control Delivery | Related to initial analysis and baseline description | Short sprint and continuous feedback | Iterative control. Activities are done at the last responsible moment | Initial analysis and iterative control |
| Rework | Try to avoid rework with preventive analysis | Continuous rework is accepted | Continuous rework is accepted | Try to avoid rework with preventive analysis |
| Risk | Estimated in the early stages | Reduced through multiple iterations (Sprint) and continuous feedback. Lack of explicit guideline | Managed using buffers to absorb variation. Activities are done at the last responsible moment | Estimated in the early stages |
| Cost | Consistent in the early stages. Highly dependent on the goodness of the predictions made and context variability | Sustained during project development | Target costing method | Consistent in the early stages. Highly dependent on the goodness of the predictions made and context variability |
| Main application | Construction, Engineering | Software | Construction, Software development, Healthcare | Manufacturing, Finance, Healthcare |

4. METHOD INTEGRATION area of interest concerns the understanding of the use cases and the ways of integration. (Rebaiaia & Vieira, 2014) (HumanWare, 2019).

## 4.1 PMBOK, LPM AND APM

*"The association between Agile and Lean is considered as a new competitive strategy concept and is claimed to be "the next wave of life-cycle process […] However, how to develop an engineering strategy based around PMBOK, Agile and Lean is not fully clear and the application of a unified framework associating them is needed than ever"* (Woods, 2010).Hibbs (2009) proposed the terminology "Scrumban" to combine the concepts of scrum (Agile) and Kanban (Lean) (Curt Hibbs, 2009). Scrumban is believed to be suitable for maintenance projects or projects where historically there have been numerous requests for rework by the end customer. **"**Scrumban" for example is an association of concepts proper to Scrum (Agile) and kanban (Lean) (Curt Hibbs, 2009).

Retrospective studies show that a part of the Agile community has begun to look at Lean approaches to combine with XP and Scrum. The union of lean and agile is winning in the Distributed and global software development project, in which the approach to group management and lean communication techniques allow to overcome the limits of Agile, which is fallacious in communications in large groups. (Razzak, 2016). Eg. As described by Woods (2010) "*SAP is expanding the application of Agile methods to the entire product creation process using a Lean framework that includes empowered cross-functional teams, continuous improvement process and managers as support and teachers*"(Woods, 2010).

About Lean plus Agile PM, Parnell-Klabo (2006) proposed a guideline and some examples of combined Lean and Agile application (Parnell-Klabo, 2006).

The literature divides between those who **consider Lean as another Agile method** and who consider it as a method category in itself rather than an instance of Agile methods. Instead, Rebaiaia recognized how to employ a hybrid of Lean and Agile development methods allows achieving "Its customers get to market 50% faster and are 25% more productive" and suggested creating a special branch of Lean PM Practices about lean-agile approach (Rebaiaia & Vieira, 2014).

The awareness that switching from Agile to Lean or associating Agile and Lean gives more clarity to the PLM process, increases customer-centricity and organizational management of

the teams (Woods, 2010) (Rebaiaia & Vieira, 2014). Many authors consider the lean as the natural evolution of agile and as the best way to introduce the concept of continuous improvement, both from the point of view of the product and the process in use. About Lean-Agile integration, please see (Woods, 2010).

Rebaiaia & Vieira, try to demonstrate that the combined effect of PMBOK recommendations, Lean and Agile methods could improve the visibility of the project management processes for making tangible profits in term of organization, dynamic cooperation, delays, and resources optimization. LPM and APM complement each other most are in the breadth of their world-view. Agile usually focuses very much within the software development team or organization, while Lean focuses on the entire system as manufacturing in the presence of workers, partners, customers, external stakeholders as possible. By cons, Agile and Lean methods both tend to focus on unstructured phases. In this sense, integration with the PMBOK could lead to the management of the project. So combining PMBOK, Agile and Lean can further enhance their usefulness (Rebaiaia & Vieira, 2014). In the last PMBOK edition, PMI suggests an Agile approach referring to Agile Release Planning (ARP). As described in PMBOK, ARP provides a high-level summary timeline of the released schedule and determines the number of iterations or sprints in the release. (Naveed, et al., 2017) (Project Management Institute, 2009).

Despite the evident advantages given by the joint application of these techniques, as stated by Rebaiaia & Vieira (2014) *"few companies are able to take on these project management approaches immediately and adopt them successfully over a short period– a full transition often taking a few years. The problem is due to the fact that despite the heaviness of the old methods, they feel safer with them and very familiar with"*. At the operational level, the addition of the traditional PM, allows overcoming the physiological barrier (ie resistance to change), which traditional companies encounter in the first implementation of lean activities.

## 4.2 PMBOK AND SIX SIGMA

As exposed by Tenera & Carnero Pinto (2014), SS and PM are recognized as naturally integrable. A correspondence between PMBOK phases and DMAIC can be easily identified, about this, please see the following table. (Project Management Institute, 2009).

Rebaiaia & Vieira quoting Lea Steve Pham, PMP, emphasizes how PMBOK and Six Sigma are two mirror images and that without the techniques of project management The Six Sigma techniques alone will not guarantee the success of the project (Rebaiaia & Vieira, 2014).

Chittoor defines the combination of Six Sigma techniques and the project management methodologies as the way to go for companies focussing on continuous improvement (Chittoor, 2012).

We recommend (Tenera & Carnero Pinto, 2014) to have an in-depth description of the topic PM, SS, and LSS.

Table 3 Suggested harmonization between PMBOK and LSS Lifecycle (Project Management Institute, 2009)

| | | Suggested Lean Six Sigma Project Lifecycle Phases | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Define | Measure | Analyze | Improve | Implement | Control | Close |
| PMBOK Project Life Cycle | Initiating | X | | | | | | |
| | Planning | X | X | | | | | |
| | Executing | | X | X | X | X | | |
| | Monitoring & Controlling | X | X | X | X | X | X | X |
| | Closing | | | | | | | X |

In particular, Puga, Soler, and Wagner (2005) proposed the DMAIC as a framework for identifying data-driven solutions and opportunities and PM standards as formal procedures for implementing the solutions found. Rever (2010) also stresses how to include DMAIC stages in projects would help project managers become more effective. Always Tender, underlines how the SS can enrich the PM of statistical instruments and deep knowledge of the process. This would improve future results through solid steps for process improvement. (Tenera & Carnero Pinto, 2014)

The 6th edition of PMBOK includes SS and Lean SS as a quality improvement method and highlighting how these methodologies can improve both qualities of the final product and quality of project managing. (Project Management Institute, Inc., 2017)

Table 4: Summary of Project management methodologies merging

| Methodologies | Main Uses | Advantages | Limits |
|---|---|---|---|
| Lean + Agile | • Maintenance projects;<br>• Projects where historically there have been numerous requests for rework by the end customer;<br>• Continuous improvement projects;<br>• Product innovation in a compressed time: | • Increases customer-centricity and organizational management of the teams;<br>• Could improve the visibility of the project management processes for making tangible profits in term of organization, dynamic cooperation, delays, and resources optimization; | • Highly skilled staff needed;<br>• Lean corporate culture needed. |

| | | | |
|---|---|---|---|
| | • New product development and process design;<br>• Distributed and global software development project. | • Avoids all communication problems<br>• Gives to the project a global structure, to manage the work with value streams, focus, and boundaries | |
| Lean+Traditional PM | • Construction projects<br>• Projects where historically there have been numerous requests for rework by the end customer; | • Increases the release frequency of value-add code;<br>• Supports team empowerment<br>• Avoids all communication problems | • Lean corporate culture needed<br>• Time expensive for the customer. A continuous involvement is required<br>• Traditional PM facilitates the first implementation of lean/agile techniques in a new lean company |
| Agile + Traditional PM | • Software development projects<br>• Product innovation in a compressed time | • Traditional PM allows focussing on unstructured projects | • Highly skilled staff needed; |
| Six Sigma+ Traditional PM | • Continuous improvement projects<br>• High budged and large six sigma project | • Data analysis increase project managers effectiveness;<br>• The statistical tool allows a deeper knowledge of the process.<br>• Traditional PM improves future results through solid steps for process improvement.<br>• It improves both the qualities of the final product and the quality of project managing. | • Planning and analyze activity are time expensive and could delay the implementation; |

## 5. CONCLUSIONS AND FUTURE DEVELOPMENTS

In the first paragraphs, we described a review of the different approaches to the PM and how these have influenced traditional management. In a context of flexibility, the PMBOK guidelines, Lean and agile methods are the best solutions to adapt to this new way of managing projects and avoiding all communication problems (Rebaiaia & Vieira, 2014). Over the years, PMBOK has begun to integrate these methodologies within its framework. This testifies that it is concrete and recognize the need to evolve the traditional approach. In the sixth edition, it incorporates in its framework agile approaches (Lifecycles and techniques) and some Six Sigma tools. The last edition of PMBOK includes a paragraph dedicated to new trends in PM processes like Agile.

Among these methodologies, there is no universally better than the other. The choice of which to implement depends, as described, on the context.

The individual methodologies have peculiar characteristics which, when combined together, make it possible to overcome the limits of the individual methodologies. Eg the lean approach favors communication within the team and facilitates work in large teams, therefore if associated with the APM it allows to overcome the limitations of the exclusive implementation of this technique to only small teams. An example of this application is the joint use of these two techniques in the Distributed and global software development project. Both the LPM and APM techniques are winning in projects that foresee a strong uncertainty in the initial specifications. The iterative approach that puts the customer at the center, allows for greater flexibility and greater compliance with the concept of value for the customer. On the other hand, both of these methods are unstructured and can benefit from the structure provided by traditional techniques. The combination of traditional and Six Sigma methodology is more natural. In this case, the traditional approach can occur in SS projects both in the initial phases of project definition and in the definition of the plan of solutions to be implemented. The union between the stage-gate approach provided by the DMAIC framework and the traditional project management simplifies the management of large projects, as in the case of a redesign of product lines or redesign of entire processes.

The focal point, therefore, is the analysis of the possible integration areas of these methodologies. The creation of hybrid approaches, which include a phase of context assessment in order to identify which techniques are best suited to be included, constitutes interesting future developments.

The analysis provided in the preceding paragraphs makes it possible to identify when it is advantageous to implement one technique rather than the other and how the combination of one or more of these may be more effective than the single implementation of one of them.

The analysis provided does not include a detailed review of the authors and cases in the literature. this limit could be overcome with future research concerning both systematic reviews and the analysis of cases reported in the literature that refer to integrated approaches.

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## APPENDIX

Tabella 5: Acronyms summary table

| | |
|---|---|
| ARP | Agile Release Planning |
| DXP | Distributed XP |
| IDOV | Six Sigma Framework, acronymous of identity, design, optimize, verify |
| AEC | Architects, Engineers, and Builders |
| APM | Agile Project Management |
| CAS | Complex Adaptive Systems |
| CTQ | (characteristic) Critical to Quality |
| DAD | Distributed Agile Development |
| DFSS | Design for Six Sigma |
| DIDOV | Six Sigma Framework, acronymous of Define, identify, design, optimize, verify |
| DMADV | Six Sigma Framework, acronymous of define measure, analyze, design, verify |
| DMAIC | Six Sigma Framework, acronymous of Define, Measure, Analyze, Improve, Control |
| DS | Distribute Scrum |
| GSD | Global Software Development |
| IGLC | International Group for Lean Construction |
| LPDS | Lean Production Delivery System |
| LPM | Lean Project Management |
| LSS | Lean Six Sigma |
| PMBOK | Project Management Body of Knowledge |
| PMI | Project Management Institute |
| SS | Six Sigma |
| TPM | Traditional Project Management |
| XP | Extreme Programming |

***Author's Contact:***
*Email: silvia.gubinelli@uniroma2.it*
*Via del Politecnico, 1, 00133, Rome – Italy*