SIE 2015
6th International Symposium on Industrial Engineering
24th-25th September 2015
FACULTY OF MECHANICAL ENGINEERING
STEINBEIS ADVANCED RISK TECHNOLOGIES
INNOVATION CENTER FME

THE AGILE APPROACH IN INDUSTRIAL AND SOFTWARE ENGINEERING PROJECT MANAGEMENT

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Abstract. *The paper presents the agile approach in industrial engineering and discusses similar ways of agile development in different disciplines. Societal changes and technological innovation brought significant changes in the market, leading to highly demanding users and frequent changes in product design. Agile is implemented in different disciplines as a response to current changes in the market. Industry 4.0 as part of "High-Tech Strategy 2020 for Germany" involves agile principles and brings latest technological trends in production process. Agile framework was firstly used in manufacturing but along with that it started to develop as a lightweight framework in software development. Agile is interdisciplinary and brings flexibility to organization. For successful implementation of agile principles, experiences and recommendations from all the industries should be used.*
Key words: *Agile manufacturing, Industry 4.0, Agile software development, Project management*

1. INTRODUCTION

Dynamic business environment and mass customization have led to changes in the production companies, and implementation of agile manufacturing systems is evident in last decades. On the one hand highly customized products requested by the clients, and on the other hand offered from the producers, caused a change from mass production paradigm to agile manufacturing [1]. The main driving force behind agility is change [2]. Nagel and Dove introduced the concept of agile manufacturing in their report [2][3] and they noticed that this theory came as response to dynamic business environment.

Throughout the years manufacturing has changed significantly. After the Second World War in the 1950s production was rigid with little flexibility with aim to produce as many products as possible at the lowest price. After that, in the 1980s quality was additional variable that should be considered and Total Quality Management (TQM) was introduced in the production. After that, competitiveness, integration and proactivity was in the focus and agile manufacturing came as a logical continuation to cope with mass customization. Normally, society was impacted by industrial change, but in the case of current changes in manufacturing it can be discussed that it is vice versa and that current social habits and needs in the society push industrial production to the next level and transformation. Use of new technologies brought more demanding needs of the customers arising from different social trends like use of social networks and smart devices [4].

Similar trend may be observed in the IT industry and software development. In the late 60s and 70s different project management associations and communities of practice have emerged (PMI, IPMA, PRINCE2) thus creating recognized standards to be used for managing projects. Software development process is project based, and definition of standard processes to be performed in project initiation, planning, implementation, control and closing was a very important step in this field. Projects in manufacturing, IT or any other industry were at that time (in 1970s) predictable, requirements were not changing rapidly and plan driven (standard) project management methods were used very well in the given business environment. Similar to introduction of Agile Manufacturing in some production companies in the IT industry Agile Software Development was introduced. Fundamental principles underlying agile manufacturing and software development are basically the same and experience and ideas from one can be applied to other.

2. TRADITIONAL PROJECT MANAGEMENT

A project management methodology is a set of appropriate repeatable processes that help introduce consistency, flexibility and efficiency while improving quality in managing an enterprise's (or department's) projects. It typically consists of process descriptions, templates, roles and responsibilities, life cycles and work breakdown Structures, together with other support information [5]. Three traditional project management frameworks are most widely used in practice and they will be introduced in this section.

The leading non-profit professional association in the area of Project Management is Project Management Institute (PMI®) founded in 1969 in the USA. PMI provides global leadership in the development of standards for the practice of the project management profession trough his standard document, A Guide to the Project Management Body of Knowledge (*PMBOK Guide*), globally recognized standard for managing projects in today's marketplace. In 1999, PMI became first organization in the world, which has its Certification Program attain International Organization for Standardization (ISO) 9001 recognition. PMI's Project Management Professional, known as PMP, certification is the world's most important industry-recognized, truly global certification for project managers.

PRINCE 2 is acronym for Projects IN Controlled Environments. It was established by The Central Computer and Telecommunications Agency in the 1989, and the UK Government uses it extensively. PRINCE 2 does not describe the techniques and approaches that a project manager can use to produce and accurate estimate. This is left to the PMBOK Guide, which describes in detail the different estimating techniques that can be used, so those two approaches are in fact complementary.

IPMA is acronym of International Project Management Association and it is a non-profit Swiss-registered organization headquartered in Amsterdam, Netherlands. IPMA is the world's first project management association, which actively promotes competence in project management for individuals, project teams, businesses, organizations and government agencies.

3. AGILE SOFTWARE DEVELOPMENT

Agility can be defined as the ability to create and to respond to change in order to create value in turbulent business environment. It is based on several business principles like continuous innovation, product adaption, shortening delivery times, adjustment of people and processes, and getting reliable results [6]. Therefore, it is common to say that agility is also the ability to balance between flexibility and stability.

Agile trends are very important today; so much that even Project Management Institute created new agile based exam in their certification program, The PMI-Agile Certified Practitioner (PMI-ACP). According to PMI, this is the fastest growing certification, which spans many approaches to agile such as Scrum, Kanban, Lean, eXtreme Programing (XP) and Test-Driven Development (TDD). PMI market research shows that Project Management practitioners are embracing agile principles as a technique for successfully managing projects [7]. Adaptability is the key characteristic of agile approach even more important than predictability, which is the basis of the traditional approach. Change is inevitable, so new approaches embrace changes and acknowledge that it is almost impossible to create complete project plan at the beginning of the project [8]. Agile approaches are more about communication and collaboration between project team members, not only about pure process following. Therefore, team members are more involved in decision-making. From 2001, with creation of Agile Manifesto, agile approach has gained more significant visibility and in this document core values and twelve principles underlying Agile are defined. Even though Manifesto was written for agile software development all of the core values can be applied almost directly to the agile project management. Core values are: individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation and responding to change over following a plan.

4. TRADITIONAL VERSUS AGILE PROJECT MANAGEMENT

Traditional approach is more appropriate for projects with clear initial requirements and clear project goals, therefore it can be said that traditional approach involves a very low level of uncertainty and for those kinds of projects are expected to have very low requirements change rate. On the other hand, projects managed by agile approach are characterized by a high level of uncertainty, unclear projects goals or incomplete and unpredictable requests and for some it could be assumed that will be significantly changed during the course of the project. With agile methods, development begins before the requirements are well defined. Also, the impact of the human factor and especially communication between project team members are more pointed with the agile approach. One of the consequences in agile project approach is the lack of documentation, so therefore, project knowledge is mainly tacit. Table 1 refers to difference between traditional and agile approach.

Characteristics	Traditional approach	Agile approach
Requirements	Clear initial with low	Creative, innovative,

	change rate	unclear requirements
Users	Not involved	Close and frequent collaboration
Documentation	Formal and required	Tacit knowledge
Project size	Bigger projects	Smaller projects
Team members	Not accentuated, distributed team	Collocated team, smaller team
Project plan	Linear	Complex and iterative

Table 1. Traditional versus Agile approach

5. AGILE MANUFACTURING

Competitive business environment forces manufacturers to continuously improve and involve new services requested by their clients and end users. Therefore, dynamic business environment and mass customization trend led to changes in the production companies transforming them from mass production paradigm to agile manufacturing [1]. Agile manufacturing is a new concept in manufacturing intended to improve competitiveness of the organizations [9].

Group of authors presented a relationship between lean (just in time) and agile manufacturing [10]. Their research shows that many authors in the field have the opposite opinion, one consider lean and agile manufacturing as mutually exclusive concepts, while others consider lean and agile as mutually supportive concepts. Lean manufacturing focus is on cost cutting and optimization of operation activities in terms of value added activities, while agile manufacturing focus on flexible production leading to agile response to customer demands. Zelenovic defined flexibility of a production system as a measure of its capacity to adapt to changing environmental conditions and process requirements [11].

Agile as a term or framework is mentioned in more areas such as: manufacturing, supply chains, business, workforce, capability, software development between others [2], [12]. Agility is referred to as flexibility of the organization or system towards external inputs, such as client demands or changes in business environment.

First industrial revolution involved mechanical production facilities in the 18th and 19th century. Following this second industrial revolution brought electrification and labor division in the end of the 19th century. Digital revolution (third industrial revolution) started around 1970s and advanced automation, electronics and IT systems began to be used in manufacturing process. Nowadays we are facing the fourth industrial revolution (Industry 4.0) which is officially recognized as a term in 2011 [13], and refers to a strategy for competitiveness for German manufacturing industry (part of "High-Tech Strategy 2020 for Germany"). According to the Industry 4.0 working group, future business will establish global networks to incorporate machinery, warehousing systems and production facilities in the shape of Cyber physical systems thus bringing completely new approach to production – embedded manufacturing systems called smart factories. This trend is also accepted and predicted by other organizations and governments: General Electric [14] presented its report on implementation of internet in production systems in "Industrial Internet – Pushing the Boundaries of Minds and Machines", US government supports R&D activities in Industrial Internet under "Advanced Manufacturing" program [15].

Industry 4.0 as a current trend in German and worldwide industry is a true example of agile manufacturing, should significantly decrease New Product Development (NPD) lifecycle and provide a solution to high demanding market requests. Group of authors made a literature review of scientific articles in this area with the aim to better define term Industry 4.0 and create ground for further applied and theoretical research [16]. In their report six different design principles in Industry 4.0 are identified: Interoperability, virtualization, decentralization, real-time capability, service orientation and modularity. Also, the four most important components in Industry 4.0 are identified: cyber-physical systems, internet of things, smart factory and internet of services. It may be observed that changes in manufacturing defined by industry 4.0 are highly dependent on latest IT technologies and that basically Industry 4.0 mean implementation of current IT trends in production companies.

6. CONCLUSION

Societal changes and development of new information technologies created fruitful ground for the 4th industrial revolution – Industry 4.0. Big data, internet of things, internet of services, social networks created new possibilities and highly specific demands of information society. This trend may be observed in process industry such as manufacturing but also in project oriented organizations. Flexible and agile approach is nowadays used in software development, manufacturing and basically any industry. Agile principles in manufacturing may be used in software development and vice versa. Practically, fundamental values underlying this change are coming from societal changes and it is logical that different industries are changing in the same way and those principles from one may be used in another. Moreover, Industry 4.0 in production is strongly reliant on new IT and involvement of big data concept in production process so it can be observed that changes that are brought by industry

4.0 principles are implemented in an agile way. In order to implement an agile framework in the organization, trends and experience from different industries should be observed and used in the best way.

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