

# Research & Education in Project Management

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# **Research and Education in Project Management (Bilbao, 2019)**

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## PREFACE

This book constitutes the proceedings of the Second International Conference on Research and Education in Project Management (REPM 2019). This scientific event was held in Bilbao (Spain) on February 21-22 2019.

Project Management (PM) is recognized as one of the best tools to create successful developments. The objective of REPM 2019 was to bring together practitioners and academics who wish to discuss and agree on the best practices in both research and education in the field of PM. The conference had close to 70 participants from academia and industry, so it finally contributed to bridge the gap between the two environments.

Continuous effort into research is the only guarantee to develop advanced techniques and tools. The PM community is being increasingly recognized through their Scientific Journals. Moreover, PM professionals feel the need of deepening in their knowledge when they face daily problems, and the University is the main instrument to educate professionals. Besides, the World needs PMs to be aware of the importance of their role into sustainable development projects. Taking the previous aspects into account, those three thematic areas were selected for this second Conference: Research in PM, Education in PM, and Sustainability and PM. Moreover, special slots were dedicated to PM in the in the digital transformation of Smart Cities.

This publication includes 9 papers selected by the scientific committee of REPM 2019. We eagerly look forward to REPM 2020.

December 2019

Jose Ramón Otegi



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# The need of professional managers in urban planning: Fighting the asymmetries

Erlantz Loizaga<sup>\*1,2</sup>, Miguel Angel Ajuriaguerra<sup>3</sup>  
\* erlantz.loizaga@ehu.eus

<sup>1</sup> School of Engineering of Bilbao, University of the Basque Country, 48013 Bilbao, Spain

<sup>2</sup> Tecnalía, Basque Research and Technology Alliance (BRTA), 48170 Zamudio, Bizkaia, Spain

<sup>3</sup> Urban and Territorial Planning Area, King Juan Carlos University, Madrid, Spain

## Abstract:

Urban planning process' are one of the most complex activities to be handle by municipalities. Currently, local authorities oversee the promotion and implementation of the general Master Plan, whereas the more detailed subsidiary Development Plans are usually led by private promotions or, in some cases, by public-private partnerships. This model causes several asymmetries and miscoordination in the development of the Master Plan. In this paper, the authors defend the need to professionalize the management process of urban development plans. Therefore, they present the asymmetries underlying any urbanization action and provide a detailed example of an undergoing development (La Atalayuela, Madrid), before presenting a new managerial model for these situations.

**Keywords:** *Urban planning; program management; professionalization*

## 1. Introduction

Classical approaches to Project management assume that every resource (including a fixed budget) is available during the execution of the project. This perspective allows to introduce several managing tools (i.e. Gantt charts or PERT diagrams [1]–[3]) during the planning stage. However, this approach is a simplistic approach to the projects' reality as they don't consider several aspects like the variation of available resources or their discontinuity, thus several control tools must be introduced during project execution (i.e. Earned Value and Earned Schedule Methods [4]) to look for a satisfactory conclusion of the project. Besides, if multiple projects share the same pool of resources, interrelation between different projects and activities as well as project criticality evaluation procedures must be considered in order to prioritize the most strategic feasible activities. As the complexity raises, this multiproject approach evolves into program and portfolio management [5], [6].

Urban planning and city expansion activities fall upon this last category, and thus, collaboration methodologies are needed to balance governance, public budgetary resources and program goals [7], [8]. Most municipalities trend to externalize the management and execution of these kinds of projects, even via Public-Private Partnerships (PPP) in order to minimize the impact of governmental changes in the municipality. However, this externalization is never complete, as programs are subdued to inconstant budget flows and fluctuations and political aspirations.

In this paper we analyse the reason underlying the inconstance between labour and economic flows, we analyse the possible effects of this economic asymmetry and we approach a solution to minimize its impact. The analysis is performed considering

the current Spanish legislation regarding urban planning.

## 2. Labour and economic flows in urban planning programmes

According to the Spanish legislation, an urban planning program must fulfil several steps including citizen participation, public tender of the directing urban program, reception of allegations, modification and public exposure of the new project, acquisitions of the terrains that are not owned by the municipality, public tender of projects execution and, finally, execution of the urbanization works. Besides, national, regional and local legislation apply during the process. Therefore, the execution of an urban planning program is a long, time-consuming process, as most experts consider them as 5-year duration activity [8]. As an important remark, even if the urbanization Master Plan derives into different Development Plans with specific timings, every one of them are part of a whole, and thus, a single discontinuity or inappropriate fulfilment may impact on other activities being developed under the same program.

Despite of being long-lasting activities, urbanization programs are driven and defrayed by public agencies, and thus, they are subdued to the economic flow imposed by the public sector. According to the Spanish legislation, municipalities lay on two main financing sources: collecting fees, taxes and other special contributions, equity performance, etc. (direct income) and perceiving tributes from higher governmental agencies both at a regional and national level (indirect income) [9].

Every public agency must approve annual year budgets, according to their estimates and the projects and programs they promote, but regardless the duration of them [9]. However, the direct income fluctuates strongly as the demographics of the city are variable and the indirect income are out of the

control of the municipality and, due to discrepancies in higher agencies, are often subjected to budgetary modifications and delays.

Therefore, the lifespan of an urbanization program is far longer than the lifespan of the economic budget supporting it and, thus, every time an economic period ends, the working program is subdued to suffer a hiatus or/and deviation of the established budget which may derive into modifications of the program scope. In the same way, any deviation from the original works may derive into a significant budgetary increment.

### 3. Case study: Master Plan of Madrid and La Atalayuela

This section presents a real case that presents several asymmetries between the economic and the urbanization flows. In order to ease the comprehension, a chronological context of the main events is presented before providing an analysis of the presented case.

Also, as planning instruments vary in each country, we have tried to keep the specific names of the different planning instruments to a minimum and using what we considered as the most suitable international equivalent when needed.

#### 3.1. Chronological summary

In 1991, the Master Plan<sup>1</sup> from 1985 (PGOU-85) led the urban planning processes in Madrid. Difficulties to access proper housing, mobility problems and the existence of industrial areas in central locations, among other reasons, made the existent plan inappropriate for the city's growth, and so, a process to create a new general plan began. In 1997, the new plan (PGOU-97) came out. However, just as the new PGOU entered into force provisionally, its final approval was contested in the High Court of Justice of Madrid (TSJM) regarding the lack of justification for the change in zoning of several protected terrains into a developable land.

In 2003, the TSJM failed against the emerging plan and nullified the reclassification of the protected non-developable lands. This judicial decision was contested and, in 2007, the Supreme Court confirmed the sentence of the TSJM. This event forced the Municipal Board to elaborate a supporting memory, in January 2008, in order to correct the deficiencies of the original plan.

However, this agreement was once more challenged and, in September 2012, annulled by the TSJM. Thus, the Supreme Court declared the nullity of the whole PGOU-97 [10].

The Municipal Government was forced to take a step backwards and made a whole revision of the PGOU-85, as it still was the municipal plan in charge, and accommodate the modifications of the revised plan from 1997. This was remarkably fast process, as it took only seven months to make a usual four-years' work. In August 2013 a new version of the PGOU was presented [11] and, in 2016 the Supreme Court ratified this final version [12].

In the meantime, several Development Plans<sup>2</sup> (PP) were elaborated in order to promote the urbanization of the different sectors contained in the PGOU-97. A Development Plan for La Atalayuela (an exclusive industrial sector of 177,54 ha) came out in 2002 based in the original 1997 plan. At that moment, the "City of Fashion", a business complex specialized in the textile and fashion industries, has been planned to be settled in this sector in 2007. Thus, the Management Board was constituted in December 2004 and the urbanization project was approved in April 2005. An expropriation bill was presented in 2007, but it had to be modified in 2010. Finally, a new Lotting Plan<sup>3</sup> was approved in 2011. However, due to the PGOU-97 being annulled by the Supreme Court, a new Development Plan was redacted on 2013.

Figure 1 shows a schematic representation of the presented timeline. For PGOU-97, the green intervals represent the periods when no sentence pronounced was against the Master Plan; in yellow, the period between the sentence against the plan (TSJM) and its final nullification (Supreme Court) and finally, in red the period between the nullification of the PGOU and the elaboration of the new plan that would eventually be approved.

#### 3.2. Analysis of the different asymmetries

The chronological evolution of the presented case highlights several managerial issues and asymmetries:

- In 2007 the Supreme Court nullified the PGOU. According to the legal impossibility to validate any regulation once it has been declared null,

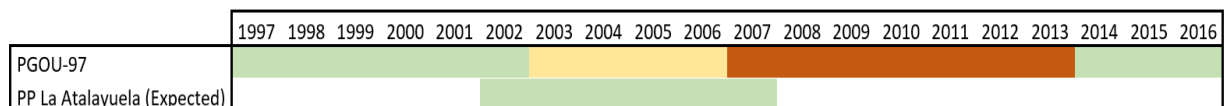


Figure 1. Schematic representation of the chronology of PGOU-97 and the Development Plan of La Atalayuela

<sup>1</sup> The term "Master Plan" is used as an equivalent of the Spanish "Plan General de Ordenación Urbana".

<sup>2</sup> The term "Development Plans" is used as an equivalent of the Spanish "Plan Parcial".

<sup>3</sup> The term "Lotting Plan" is used as an equivalent of the Spanish "Plan de Reparcelación".

this rendered any posterior amendment to plan useless and, so, the only viable alternative was to elaborate a new plan considering the previous PGOU-85. However, this approach was not considered until 2013.

- The Development Plan of La Atalayuela is subsidiary to the PGOU as it provides a detailed plan for the sector of interest. However, the chronology shows that the PP was mostly elaborated and developed after the TSJM nullified the classification of non-developable lands referred in the PGOU.
- Even if the PGOU was being contested in court, the development of La Atalayuela keep the expected schedule and most of the urbanization process was finished by 2007. However, the final judicial decisions disqualified the PGOU and all the subsidiary Development Plans. Therefore, it was impossible to edify on the already urbanized sector.
- Due to the economic crisis affecting Spain in 2008 and the PGOU being nullified, the “City of Fashion” projected was never materialized. The first industry set in La Atalayuela in February 2018.
- The industrial sector of La Atalayuela remind dessert for several years, even if all infrastructures but green zones were completed for 2007. The maintenance of such infrastructures implies a great overrun for the municipality.

### 3.3. Integrating a professional Steering Board to deal with asymmetries

The presented case study shows that an urban planning process is so complex than overpasses the single project perspective, and so, program and portfolio managing methodologies should be considered when undertaking these processes. Furthermore, public endeavours, especially those dealing with urban public, must deal with a great number of stakeholders and external factors that affect the normal flow of the project, including the interaction with the economic and tributary cycles.

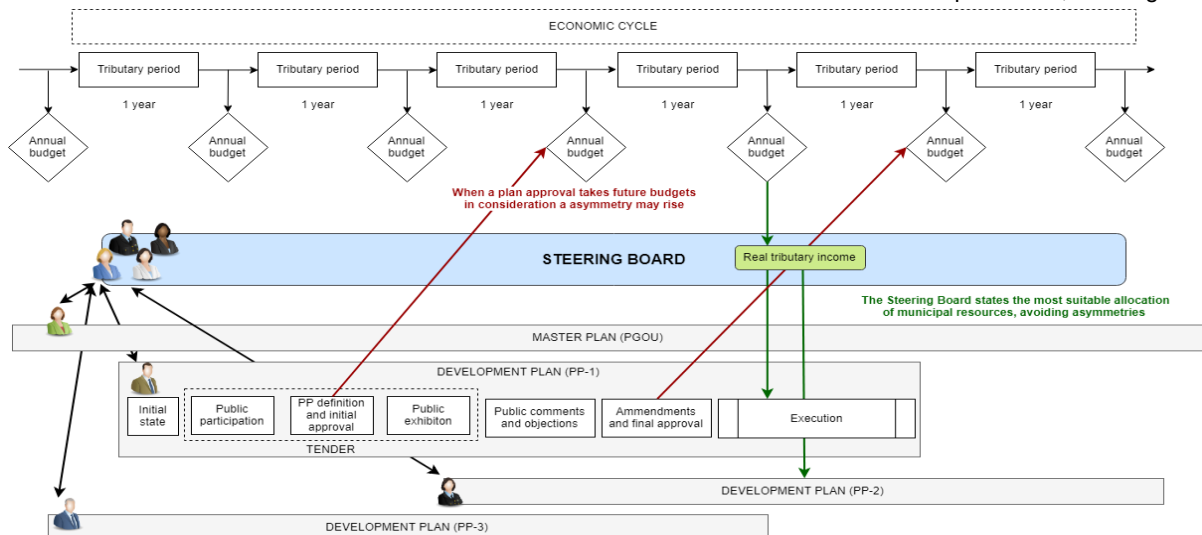
In the presented case, the PGOU (and,

consequently, every PP subsidiary to it) suffered a great delay due to environmental circumstances triggering a complex legal process. This circumstance meant, not only a delay in the implementation of the PGOU, but also a significant cost in terms of human and legal expenses. Additionally, the economic crisis had a negative impact on the outcome of several urban process, such as La Atalayuela. A risk management methodology like a PESTLE analysis would help to detect these issues and plan the corresponding corrective actions in advance, thus minimizing the impact of these external circumstances. Furthermore, considering a project as a dynamic system, this information should have been updated according to changes in both external and internal factors of the whole PGOU system.

The main problem on the presented case is the independent managing system of the PGOU and its subsidiary PPs, leading to the inexistence of dynamic control of the different entities conforming the urban planning system. The Municipal Board deals with the administrative aspects of the PGOU and each of the subsidiary PPs, but the real promotion and development of each plan is led by different project managing teams with no explicit interaction among them. As a consequence, the urban planning system lacks a proper systemic integration of the Development Plans, despite the legal framework provided by the PGOU.

In order to cope with this situation, we propose the integration of an external Steering Board to centralize the development of the different urban plans in correspondence with basic principles of governance such as impartiality, public information and collaboration.

The Steering Board would consist in professional program and portfolio managers that would have a double role. First, it would act as a program manager, actively collaborating with the different managing teams of each development plan in order to manage the possible interdependencies between the different PPs and aiming for the achievement of the goals defined in the PGOU. Second, it would collaborate with the Municipal Board, offering real-



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Figure 2: Using a professional Steering Board to deal with asymmetries

time measures, timing and financial analytics and status reports of the different urban plans under development. They would also collaborate in the definition of eventual risk scenarios and state the most suitable allocation of the municipal resources according to the annual budget in order to achieve the optimal planning prioritization strategy for the goals established in the Master Plan.

The Steering Board should be in constant interaction with the different stakeholders involved and should accomplish a continuous update of the planning process and a periodic review of the whole urban system, including, at least, an annual agenda for the last tributary period and a strategic roadmap to accomplish every development plan according to the PGOU. Also, considering transparency as a fundamental issue to achieve the aforementioned principles of impartiality, public information and collaboration, the Steering Board should pay special attention to the form, content and periodicity of the communication, both to active participants of the planning process and to the general public.

#### 4. Conclusions

Urban planning is a complex process, promoted by the public sector that involves a variety of stakeholders and affecting multiple factors of the municipality, such as environmental, economical, political and social factors. Because of this, it becomes a challenging experience for any technical involved in the preparation and further implementation of the Master Plan and its subsidiaries Development Plans.

In the classical approach, there are many entities involved in this process. Traditionally, the municipal Board leads the constitution and development process of the Master Plan, whereas private promoters or, occasionally, public-private partnerships lead the implementation of the Development Plans. However, this leads to discoordination between the different agents and, occasionally, to serious asymmetries among the processes that may compromise the goals established in the Master Plan.

As a counterpoint to this traditional model, this paper presents an alternative managing system based on a professional Steering Board that would coordinate the different Development Plans within the Master Plan, favouring a more integrated development in order to achieve the goals established in the Master Plan.

The model we present is analog to the one followed by the city smartization projects within the H2020 program. Currently, several municipalities take part in these projects to create new IT infrastructures and services, yet they are not usually led by the municipalities but by IT experts [13]. Similarly, even if public agencies are the ultimate responsible of urban planning, integrating the suggested Steering Board would promote the professionalization of the urban planning management leading to better results or, in worst case scenarios, minimizing the negative impact of external factors.

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# Organizational Change Projects Methodology for Literature Review Keywords Definition

Markel Delgado Valcárcel, Francisco Sánchez Fuente, Joserra Otegi Olaso

[mdelgado002@ikasle.ehu.eus](mailto:mdelgado002@ikasle.ehu.eus)

[francisco.sanchez@ehu.eus](mailto:francisco.sanchez@ehu.eus)

[joserra.otegi@ehu.eus](mailto:joserra.otegi@ehu.eus)

University of the Basque Country (UPV/EHU)

## Abstract:

One of the main target of companies is to obtain competitive advantages that allow them to improve their business results. For this purpose, many companies start working on projects that will help them to achieve their goals. These projects are often important enough so that they can be considered as organizational change projects. The scope definition of this kind of projects entails important risks, as if it's not accurate enough regarding the requirements from the company, project success probabilities will decrease. With the present methodology we seek to overcome this barrier, by establishing a process that provides them with an organizational model to implement in the organization. This model seeks to improve project scope definition and response to the expectations from a machine tool manufacturer that aims to increase business profits and gain competitive advantage by means of operational excellence.

**Keywords:** *Organizational Change Projects, Operational Excellence, Project Based Organization, Lean, Six Sigma*

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## 1. Introduction

With the intention of achieving operational excellence (OE) and obtain bottom line improvement, and usually guided by external consultants, many companies start working on improvement projects. If the improvement expectations from the company are important enough, those projects will entail major changes within the company. This fact is key for the definition of the project, as it cannot be just defined as an improvement project, and it must be framed in the organizational change projects framework.

According to the goals and methods matrix [1], organizational change projects are defined as type 4 projects, which are those for which both the goals and methods of achieving them are poorly defined. This lack of clear project scope definition and methods will jeopardize the achievement of the expected improvements from the company, thus solutions must be provided in order to improve project success probabilities.

With the present methodology we seek to overcome these two barriers. First, the use of a specific method to proceed with the literature review, from which the organizational model to be implemented will emerge, will improve the scope management activities. Then, by means of the literature review, we seek to use existing knowledge that will both improve methods and goals definition.

## 2. Contextualization

This keywords definition methodology is part of a MSc Thesis that seeks to establish the basis for an upcoming PhD Thesis. This methodology aims to facilitate the literature review process that will be

carried out during the Thesis construction, as the field of research will be delimited by the keywords that will emerge from this process.

The baseline for this methodology emerges from a real case of organizational change project. A machine tool manufacturing company has decided to start an organizational change project, with the intention to gain competitive advantage through OE, as well as to obtain bottom line improvement. The company is currently process driven, and their target is to obtain this competitive advantage by providing on-time and high-quality products to its customers. Based on this target, the company has established a set of organizational characteristics, that respond to the current issues they have that are not permitting them to gain competitive advantage.

## 3. Objectives

The main goal of this article is to establish a methodology that improves organizational change project success probabilities. This success probabilities improvement will come by establishing a literature review keywords definition process. In the other hand, the organizational model that will emerge from the literature review will improve the scope management activities, as the model to obtain will be part of the goal's definition process.

Attending to the keyword's definition process, we will first analyze if the selected organizational characteristics from the machine tool manufacturer are aligned with an existing reference framework for the OE concept. Regarding the organizational model definition, this remains out of the scope from this article, as it will emerge from the upcoming literature review that will be carried out in the MSc Thesis. Nonetheless, we will explain how the

definition of an organizational model has a positive impact on project success probabilities.

**4. Phases from the developed Methodology**

This methodology is divided into four parts, it starts with the inputs from the organization and ends up with the literature review and keywords definition. In the upcoming paragraphs we will deploy the related activities to each of the stages.

**4.1. Organizational Characteristics Definition**

The machine tool manufacturing company has established a set of characteristics from the organization they want to become. These characteristics have been divided into three different constructs: Core values, production system properties and intended business outcomes. The first construct defines the way the company should work (interdepartmentally and aligned with common targets) and worker’s responsibilities (Everyone should comply with their commitments). There is as well a special mention to the pride of belonging to the company, due to the fact that this machine tool manufacturer is established as a cooperative society.

In second place, the production system properties are established. These properties are focused on establishing a process-oriented continuous improvement philosophy, seeking to focus on value-adding activities (by means of daily management meetings) and adapting production means based on customer demands. At first sight, we can affirm that the company seeks to adopt lean and Six Sigma production management methods.

Finally, the intended business results are defined. The company aims to generate high added-value products for its customers and obtain enough business operative results in order to maintain their investment policy.

As this list of requirements has no scientific ground, we will compare them with an existing reference framework for the OE model, namely Shingo Model, to confirm that the selected characteristics respond to the requirements from OE. The Shingo model [2] is a reference model for operational excellence based on the study of several improvement initiatives, such as Quality Circles, Just-in-Time, Total Quality Management, Business Process Re-engineering, Six Sigma and lean, among others. Shingo model differentiates four different dimensions for operational excellence, cultural enablers, continuous process improvement, enterprise alignment and results.

Core Values	Pride of belonging to the company
	Collective alignment and communication
	Cross-departmental and transversal
	Compliance with commitments
Production System Properties	Manpower versatility
	Ultra-modern or robust productive means
	Capacity to deal with changing customer demands
	Planning (Adapted to each manufacturing product)
	Continuous improvement process engineering
	Effective problem-solving capacity
Intended Business Outcomes	Culture changing
	Effective daily management meetings
	Produce products that provide added-value to the customers
	Obtain profits to reinvest and keep on growing

Figure 3 Organizational constructs characteristics

Attending to the characteristics of the company, there are some similarities and differences with regard to the Shingo model. First, the model defines the cultural enablers focused mainly on leadership and respect with every individual from the organization. On the other hand, the company understands the culture enablers as company’s core values, which are more related to daily activities (compliance with commitments and interdepartmental work) and pride of belonging to the organization.

The alignment with the second dimension of the Singo model is clearer. The company has defined a sort of characteristics that lead them undoubtedly to use a similar approach to the one defined in the model. Effective problem-solving, continuous process improvement engineering or product adapted planning (Specific to its manufacturing process characteristics), require a strong focus on processes, the adoption of scientific thinking and search of perfection. The capacity to deal with customer demands, and considering lean production systems characteristics [3], requires working under pull type production (produce only what your customers demand). Finally, daily meetings are an effective tool to keep production flow safe and, together with the use of significative production indicators, are useful to analyze deviations and establish quick corrective actions.

Enterprise alignment is a key concept that both the model and the input from the company consider to achieve operational excellence.

Regarding results dimension, the company focuses on value-creation for its customers, as well as in the obtention of profits that would allow them to reinvest and keep on growing. Shingo model identifies in this last dimension only the creation of value for customers and doesn’t consider the internal value creation (in terms of operational profits).

To sum up, we can confirm that the established organizational characteristics from the machine tool manufacturing company satisfy three dimensions of the Shingo model. There is only as mismatch on



cultural enablers, as they are not equally defined in the inputs and in the Shingo model.

**4.2. Decision Matrix Design**

The decision matrix is the tool we will use to select the most representative keywords with regard to the received inputs. This matrix will prioritize the keywords for each of the organizational construct, considering the relative weights of each defined characteristic and the individual evaluation of the keywords. The figure below depicts the obtained results for the keywords appraisal with regard to the core value construct.

Relative Weights	15%	10%	20%	55%		
Core Values Decision Matrix	Pride of belonging to the company	Collective alignment and communication	Cross-departmental and transversal	Compliance with commitments	%	Graph
Project-Based Organization	10	10	30	40	31%	████████████████████
Six Sigma	10	20	30	25	23%	████████████████████
Organizational Alignment	30	50	15	15	21%	████████████████████
Lean Manufacturing	20	10	10	10	12%	████████████████████
Change Management	20	5	5	5	7%	████████████████████
Sustainability	10	5	10	5	7%	████████████████████

Figure 4 Core Values Decision Matrix Design

As we can see in the core values decision matrix, the selected characteristics are represented in columns, while keywords are organized in rows. Each keyword is assessed with regard to each characteristic, in order to obtain finally a Pareto diagram (without cumulative curve) that provides the relationship of the most significant keywords for that particular construct. The assigned characteristics to each construct have been assessed as well by the company. In this case, the most significant characteristics have higher relative weight within the core value, depending on its importance according to the company's criteria. This criteria has been established considering the biggest issues from the company, according to the board of directors, that doesn't allow them to obtain the expected competitive advantage.

The selected keywords for the decision matrix have been selected accordingly to the presented core values and characteristics from the company, attending to the theoretical concept of the keyword itself. Lean and Six Sigma concepts are introduced as they have been named as the most powerful tools to gain the much-desired competitive advantage. Companies that had used both lean and Six Sigma methods can improve substantially their product lead times, reduce manufacturing overhead and quality costs and improve delivery times [3]. This would respond to the company's expectations to obtain bottom line improvement, so as to improve their capacity to deal with customer changing demands and problem solving.

The Project-Based Organization (PBO) management system has been introduced due to the fact that Six Sigma method is a project-driven management approach [4]. Moreover, comparisons to the traditional organizational forms demonstrate that PBO's main differentiating characteristics are flexibility and dynamism [5], that would enhance the effect of lean and Six Sigma within the organization.

The concept of sustainability has been added under its financial point of view, as company's expectation is to obtain enough business operational profits so as to keep investing and improving their productive means.

Organizational alignment and change management are also inputs to the decision matrix. The first one is key for obtaining the necessary alignment within the organization to achieve the defined requirements. Finally, change management concept is key as well for an effective management of the process that will take the organization from the current status to the desired one.

**4.3. Prioritization of the Organizational Characteristics**

The appraisal of the keywords for each construct must be carried out considering the theoretical concept of the keyword itself, and evaluating how important its impact can be for the presented requirement from the company. In the figure below the evaluation of each keyword with regard to the three organizational's constructs is presented.

	Core Values	Production System Properties	Intended Business Outcomes
Project-Based Organization	31% ██████████	4% █	12% █████
Six Sigma	23% ██████████	16% ██████████	20% ██████████
Organizational Alignment	21% ██████████	5% █	7% ███
Lean Manufacturing	12% █████	26% ██████████	20% ██████████
Change Management	7% ███	4% █	3% █
Sustainability	7% ███	6% ███	38% ██████████

Figure 5 Evaluation of the selected keywords regarding the three organizational constructs

Attending to the obtained results, PBO, lean manufacturing and Six Sigma are the most significant keywords to proceed with the literature review, as they are the most suitable ones to fulfill the requirements from the machine tool manufacturer.

Indeed, by means of a good structured PBO that prioritizes projects based on their impact on organizational strategy, and creating project teams on that purpose, organizational alignment can be achieved. Due to the fact that in projectized organizations people assessment is made according to the success they have achieved in the projects they have taken part, project work will be prioritized for project team members.

Regarding lean and Six Sigma, these two keywords are the most suitable management tools that can create the expected production system for the company. While lean enables the organization to change its manufacturing means depending on the customers' demands, Six Sigma can establish an effective method for problem solving, as well as improving processes by the use of process indicators.

Thus, the organizational model to develop will emerge from the literature review that will be carried out with these three concepts. There is a lack of knowledge in the existing literature for a specific

model that embraces these three concepts. According to Cherrafi et al. [6], existing literature has demonstrated that lean and Six Sigma can be combined in a specific model, but they do not either target the operational excellence. In this sense, Cortes et al. [7] have presented a reference framework that aligns lean and Six Sigma indicators with the strategic management of a company, but it doesn't include the PBO concept. Therefore, the organizational model to present can respond to this lack of knowledge in the existing literature.

#### 4.4. Literature Review and Definition of the Organizational Model's Components

Once the keywords have been selected, the literature review can be carried out. The research field must be restricted to the journals specialized in those areas of knowledge. Once the theoretical elements have been defined, the elements of the model will be presented. This model must respond to the strategic management processes, down to the operational processes, in order to align the assigned indicators to each level. The organizational structure must respond as well to the requirements from each level, not to let the processes unattended.

#### 5. Conclusions

This presented methodology seeks to improve the probabilities of achieving success in organizational change projects. As many projects fail due to the lack of understanding or project definition and product scope at the start of the project [8], this methodology helps to the objectives of organizational change projects. According to Mirza et al. [8], in the process of scope definition three steps are identified:

- Identificate the factors involved in starting a project
- Clearly definition of the objectives
- Identificate measures of performance

As we can see, this methodology will have a positive impact on the second step of project scope definition. On the other hand, this methodology helps as well on the organizational change project that is currently on going in a machine tool manufacturing company. As it has been previously proofed, the selected keywords that will define the organizational model respond to the expectations from the company.

The followed process has a very pragmatic approach. It starts with the definition of the expectations from a company that aims to improve their business results. The company itself defines which are the organizational characteristics they would like to have and ends up with an organizational model to implement within the organization that responds to those expectations. By means of the literature review, the organizational model to present will take advantage from the existing knowledge, what will improve success probabilities as well.

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# Tailored Approach for Self-Organizing Teams in Software Development

Maksym Kovalchuk<sup>1</sup>, Anatoliy Sachenko<sup>1</sup>, Carsten Wolff<sup>2</sup>

<sup>1</sup>kow.max7@gmail.com

<sup>1</sup> Ternopil National Economic University, 3 Peremoga Square, Ternopil, 46004, Ukraine

<sup>2</sup> Fachhochschule Dortmund, Otto-Hahn Str. 23, 44139 Dortmund, Germany, carsten.wolff@fh-dortmund.de

## Abstract:

The paper describes a custom software development framework based on agile Kanban continuous flow method for the creation of real-time human detection system in video streams in a small self-organized team. The development of such a system requires an approach, which would account for uncertainty factor common in the complex software projects. The devised framework incorporates and adapts different agile as well as traditional approaches and instruments to complement Kanban method in terms of product planning, team and risk management, issues management, engineering practices, and system analytics. Additionally, within the scope of this work, the efficiency of the project and the corresponding metrics were analyzed and assessed. The proposed methodology has received experimental confirmation and can be viewed as a valuable knowledge base contribution.

**Keywords:** tailoring; hybrid project management; software development; Agile; Kanban; case study.

## 1. Introduction

The process of creating software is not uniform [1]. A particular method of software development, as a rule, determines a certain dynamics of the deployment of a particular type of activity, that is, determines the process model, but doesn't ultimately defines it [1]. For the adaptation of each specific project only a limited set of methods will be applicable for each specific stage and process of developing this software [1].

To address this problem and be truthful to the ideological principles of agile management, companies are starting to implement the mixed approaches in their developmental efforts [2]. Mixed methodologies include combining the methods of several methodologies [2]. The 12th State of Agile Annual Report [3] notes (Figure 1) the uneven distribution of employed software project management techniques indicating that the method of mixed development is a common method of process organization among modern development teams. A number of studies, such as studies of Cockburn and Cheema, are also devoted to the issues of tailoring of programming methodologies and suggest the development of mixed methodologies and frameworks as the next step in the evolution of traditional Agile [2].

Modern models and methods used in real software development projects are very diverse [21]. Each of them has its own advantages, which are manifested in appropriate conditions [2]. When implementing a hybrid methodology, it is important to take into account the problems, specifics and architecture of each approach [22]. For that reason, before trying to combine the desired approaches and features, it is necessary to explore them in detail before incorporating them in a holistic manner.



Figure 1. Distribution of Agile techniques.

Taking into account the results of the PMBOK, suitability assessment model [14], this work proposes a modified Kanban method for use as a primary developmental structure for the project in the field of computer vision. Namely, the creation of a product, that detects people faces in static environments in two dimensions, which utilizes LBP recognition in combination with supplementary face detection and recognition methods. The project is characterized by a high degree of uncertainty regarding the limitations and functionality of the system, team size of 3 team members (including PM), little to no experience among the participants, decision making capabilities, criticality requirements and characteristics of the final product i.e. the ability to alter the code of the computer system efficiently and account for the likelihood of change.

## 2. Overview of the Models

Scrum and Crystal Clear demonstrate a participative philosophy of team management and work ethics practices [4][5]. The list includes tools such as retrospective and reflection, frequent delivery and focus on the feedback within the team [4][5]. Other frameworks have a unique set of engineering and practical development practices, such as continuous integration and development of XP (Extreme Programming) [6] and Kanban [7]. A feature of DSDM [8] (Dynamic systems development method) is the use of the post-project stages, and ASD [9] (Adaptive software development) and FDD [10] (Feature Driven Development) are built on the principle of full-fledged management and engineering solutions that can support large groups of developers and aim for large-scale productions. The descriptive methodology of ICONIX is almost waterfall in nature, and needs to be adapted for agile methodologies, but promises agile and lightweight solution to architecture mapping [11]. A number of agile software design methodologies and methods have proven to be complementary to each other. The most popular of them are Scrum and Kanban, forming the so-called Scrumban [12], as well as Scrum + XP [13]. The latter allows for organizing the process of improving teamwork efforts through a gradual project goal evolution by successively conducting tests after each iteration / completed task with the adjustment of subsequent tasks based on the analysis of previous results.

However, a situation may arise when existing renowned models and their respective derivatives prove to be completely or partly inapplicable. In this case, modern development teams may focus the efforts on developing the framework around their production processes. Project managers therefore need to resort to tailoring in accordance with particular needs of the projects and devise the hybrid approaches, which provide more degrees of freedom. Such approaches may combine not only the agile models but predictive (traditional) and agile models altogether.

## 3. Proposed Approach

It is proposed to select and tailor a hybrid Agile methodology in order to find new means of organizing the workflow by combining the development models and approaches along with the development of the software itself. The focus of the methodology would be centered on three developmental frameworks: Scrum (team management aspect), Kanban (Kanban board and metrics) and XP ('You Aren't Gonna Need It' principle [32], engineering techniques). The PMBOK regards this mix of approaches as a solution that "produces a synergistic result of higher performance than each individual component in isolation [14]." The project would manifest itself as an exploratory case study aiming to develop a framework allowing for wider range of applicable project management techniques and agility capabilities.

In this project, the Kanban method, as the main development framework, will serve as an integral basis for gradual, evolutionary processes and changes. Some of the methods and processes traditionally used in traditional or agile approaches were integrated into the developed management system in order to transform the Kanban method into a holistic development framework. The abstract problem of such integration implies the need to address the alignment of aforementioned approaches with the project management knowledge areas [14] and the development management techniques themselves.

The key features the framework introduces are: stakeholder management through early user involvement and requirements analysis; time management with designated simulation tools; scope and integration management with system mapping techniques; quality management by means of task evaluation and specification guidelines as well as code quality assurance methods; human resource and communication management via environmental analysis. Traditional Kanban does not contain risk management discipline, for that reason framework adapted classical approaches of risk management, adhering to the principles of Agile (risk-adjusted backlog).

In this regard, the devised framework encompasses range of tools and methods to complement the Kanban Method, such as Monte Carlo simulations [23] for schedule control and Clustered Blockers [24] for issues mitigation all layered in a complex administrative system including: custom project vision canvas based on the business canvas of A. Osterwalder [25] and the rolling wave approach, Kano modeling [26] for functional analysis, task definition and team forming guidelines, CDE (Containers/ Differences/ Exchanges) model [27] for team interaction and feedback management. Risk identification is handled with the usage of SEI Taxonomy questionnaire [28], the subsequent control/monitoring, and correction with the help of the MSF Ver 1.1 Risk Management guidelines [29] along with adapted Scrum retrospectives and poker planning. ICONIX process [30] and continuous integration methods, refactoring and TDD (Test-driven development) [31] application are also integrated in the development model.

The centerpiece tool for monitoring and controlling the flow is a modified task board from Kanban (Figure 2). The stickers indicate the name of the task and the belonging to the group (task-set), they move according to the corresponding states during the execution. Each column of the board may be viewed as a phase-gates with team making a decision to move the task into the next column. The Backlog and Next Up column contains all current tasks, sorted vertically by importance. The Buffer columns are designed to help to maintain the stability of the system. Buffers (queues) in the form of additional columns contribute to the amount of incomplete tasks in the system, which slightly increases execution time [15]. However, buffers and

queues make the workflow more uniform, which improves the predictability of the execution time [15]. The introduction of buffers allows Kanban system to handle more tasks as they help to balance increased work demands against available capacity [15], serving as a risk-adjusting Kanban board elements that give team the needed time to account for the risks.

The framework poses itself as a middle ground between the two approaches proposed by A. Reddy [15] (time-bounded Kanban) and Corey Ladas [16] (takt-time Kanban). The entire life cycle of the project is continuous, but divided into conditional task-sets (e.g. MainForm3, see Fig. 2), similar to sprints in Scrum, but not limited in time. They are only of a formal nature in order to be able to evaluate the dynamics of productivity, and chronologically simplify the tracking of completed tasks. The task-set is finished when the last item of the particular item group reaches the Done column. Each such conditional iteration ends with a discussion i.e. Scrum-like retrospective, thus conferring the framework the Scrum-like features. A demonstration of the results in the end of each task-set is performed in a simplified scheme, only those tasks that require additional comments are examined collaboratively, the supervisor is able to review the rest himself.

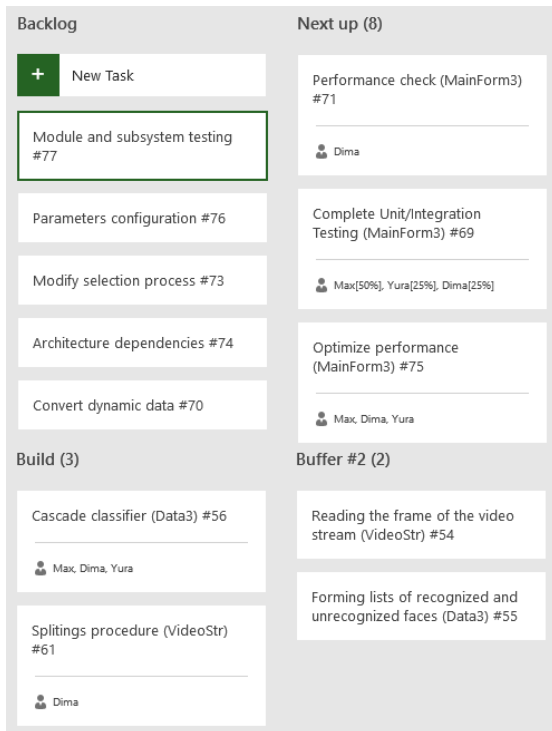


Figure 2. Part of the Kanban board with buffer and work elements in MS Project.

The object-oriented analysis and design (OOAD) approach [33] of the framework is represented in the form of continuous feedback loop across all knowledge areas tied in with a Kanban board serving as the main visualization anchor. The board

implies a maximum narrowing of the target scope of visual modeling, which is a significant part of OOAD [33], - to create lightweight control methods and visual modeling tools to solve a specific problem [17]. Due to this, team noted the ease of understanding the needs of the project and consequent achieved control of decisions on the technical side. The idea of such object-oriented modeling and management is supported by a number of specialized tools. Due to the relative novelty of the idea and the complexity of its implementation, today only a few of them are sufficiently stable and developed to be considered ready for use in the industry [18]. One of the most famous [19] such tools which this framework complements are Microsoft products, in particular Azure DevOps, Project, Visio, Visual Studio and Excel (Figure 3). The Azure DevOps (former Visual Studio Team Services) allows to connect with the Visual Studio (the IDE of choice) to export the code for refactoring and code smells analysis on the SonarQube [34] platform. The latest version of MS Project Online introduced the ability to work with Agile tools and Kanban in particular. The MS Excel serves as a flexible tool for managing and exporting project data for metrics visualization or analysis via third-party applications such as ActionableAgile [35].



Figure 3. Primary tools of the methodology.

#### 4. Evaluation

Control of the project was carried out at all stages of its implementation, providing an opportunity to influence the progress of the project in such a way as to ensure its maximum efficiency. Analysis of the efficiency of the project implementation allowed to determine how well the achieved results correspond to the goals set by comparing the project development indicators (Kanban metrics) at the previous and subsequent stages of product implementation. Metrics evaluation indicated a clear improvement in WIP (Work-in-Progress) age, Throughput and Cycle time. CFD (Cumulative flow diagram) showed stable flow alignment (Figure 4) and flow efficiency at around 90%. Clear vision, communication practices and project issues control also contributed to the accurate adherence to the planned course.

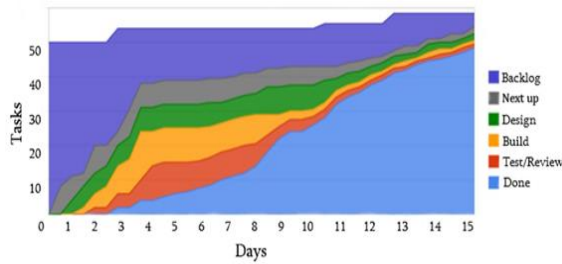


Figure 4. CFD of the 15th day (out of 30) without buffers.

The abstract solution of the proposed methodology suggests that it is possible to bridge the gap between frameworks of various application fields and structures in order to interconnect the process flows to suit the needs of the project, e.g.: the combination of classical and agile risk management to achieve fast turnaround time of the risks involved; adaptation of predictive UML/ICONIX modeling to account for the undefined elements; Kanban's continuous flow and Scrum's lessons learned activity.

The effectiveness of the project can be defined as a measure of compliance with the achieved and planned goals. The fact of achieving the goal set [20] should be considered the most important criterion (qualitative sign) of the project and framework effectiveness and may be correlated with the applied tailored approach (Figure 5).

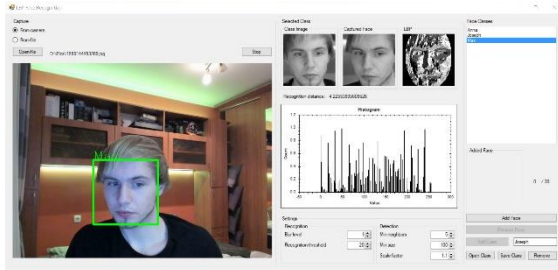


Figure 5. Developed software.

## 5. Conclusion

The object of study are project management processes, the subject - a project for developing software in the field of computer vision. This type of projects is a very complex problem which requires an integrated, systematic approach. In this regard, a thorough analytical study of the area was conducted, during which important elements were identified and a development model was drawn up from the point of view of the managerial and IT aspect of the development. Due to a number of reasons, there are no universal methods for software modeling. The work suggests that this is due both to the fact that software products do not have and cannot have a common accepted metaphor for implementation due to their unique architecture, and to the fact that currently there is no universal software development process. To resolve

this problem, it was proposed to broaden the capabilities of the Kanban method and introduce more degrees of freedom to this useful agile tool by developing a custom framework. The created version of software development framework proved itself to be a viable solution for developers resulting in the creation of a reliable and precise software. The precision scores range in about 90% correct recognition rate within the functionality and requirement boundaries of the program.

Developed framework provides a wide field of possibilities for use in the form of methods and techniques of different methodologies, thus manifesting itself as hybrid solution for software development teams. The methodology is based on the continuous flow method, and utilizes a visual notation tool for achieving software design and project management synergy - enhanced Kanban board. The framework is designed to help the team better understand the structure of the information product: the information elements included in it and the links between them. The syntax of the visual models, integrated techniques and the infrastructure of software tools for their support allowed to enhance the Kanban method and recommend the developed methodology as a promising IT solution.

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# Application of Blockchain in Agile Methodologies: Scrum and Kanban Approaches

Imanol García Pastor, José Ramón Otegi Olaso, Francisco Sánchez Fuente  
igarcia961@ikasle.ehu.es  
University of the Basque Country (UPV/EHU)

## Abstract:

Agile methodologies are focused in a fast and continuous value delivery for the customer while maintaining a high adaptability to changes. Due to this there are weaknesses that are not yet resolved. Issues such as documentation, accountability and scalability have room for improvement. But this must be done without impacting the main capabilities of Agile. The application of blockchain in this field could facilitate the improvement of these aspects and open new perspectives. Making both technologies work in the real world is a challenge that can take agile project management to a new dimension. With this in mind, a proposal for the application of blockchain in agile methodologies is done taking into account two different approaches: Scrum and Kanban, and identifying those aspects that this new technology can enhance.

**Keywords:** *project management; blockchain; scrum; kanban; agile.*

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## 1. Introduction

The Blockchain (BC) technology has demonstrated broad capabilities to be considered disruptive in different areas and sectors. It mainly consists of an immutable distributed record of transactions, stored on the participating computers, which allows trustworthy operations to be carried out without the need for a central authority [1]. In its second version BC supports the concept of Smart Contracts (SC) which has extended its opportunities to a wider area of applications. Its use provides security and trust, transparency and disintermediation [2], achieving that businesses and classic processes increase their capacities boosting the possibilities of collaboration, lowering the costs and decreasing the times of the operations. These characteristics are found within the principles of agile project management. It thus seems interesting to investigate possible applications of blockchain technology (BCT) in this field, in order to increase the efficiency of these methodologies and to address the new challenges they face [3], as it is the application of agile methodologies in a wider and more distributed environments [4].

## 2. Objectives

The main goal of this article is to identify how the use of BCT could be leveraged in agile project management, trying to get a glimpse of how can be a real implementation.

To do this, two of the most used agile frameworks are introduced, revealing a proposal for the application of BC in each one, and trying to find the best fit in the process. During the discussion phase, the areas that strengthen the application of this new technology are highlighted. At the end of the document, the most relevant conclusions are summarized, outlining further research topics.

## 3. Agile Methodologies

Agile methodologies are those whose values and principles are represented in the 'Agile Manifesto'[5], prioritizing collaboration, adaptability to changes, functional incremental implementation, and customer relationship over other aspects. There are several frameworks to implement agile methodologies in the most optimal way depending on the circumstances and the work to be done. Scrum and Kanban [6] are two different widely used approaches, and sometimes they can be combined to obtain the best of both, giving rise to new implementations such as Scrumban.

### 3.1. Scrum

Scrum is an agile methodology that, although it can be used in any type of project, adapts very well to the development of a specific product. It is built up of three main groups

- Roles: Product Owner (PO), Development Team, Scrum Master (SM).
- Events: Sprint, Sprint planning, Daily Scrum, Sprint review, Sprint Retrospective.
- Artifacts: Product Backlog, Sprint Backlog, functional increments.

According to Scrum the implemented functionality generated in each sprint have to be usable even commercially. The definition of the concept of 'Done' for both, the backlog elements and the intermediate versions must be clear and understood in the same way by all participants.



**Scrum Process**

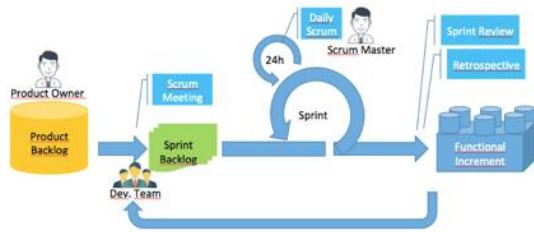


Figure 6 Scrum Process

Usually in Scrum the PO is responsible for maximizing the value of the product, optimizing the efficiency of the work done by the development team. To this end, he constantly updates the elements within the backlog according to the needs of the customer and/or market, arranges them according to priorities and ensures that the team understands them (Figure 1).

During the Sprint Planning phase (Figure 1), the development team selects a subset of the elements present in the Backlog for implementation, getting a new functional version at the end of the sprint. During its execution, the SM is in charge of ensuring that the Scrum process is carried out correctly. The result achieved is checked during the 'Sprint review' meeting, agreeing on the tasks that have been fulfilled entirely and which need more iterations. The process itself is also reviewed during the retrospective phase, helping to improve the team on that project for the future.

In Scrum, the development team must contain all the skills necessary to carry out the project and must be self-organised.

Therefore Scrum, like the rest of agile methodologies, aims to maximize the creation of value throughout the development of the project by launching preliminary versions incrementally improved.

**Advantages of Using Blockchain in Scrum**

BC has been presented as a disruptive technology in a wide range of sectors and business areas [7]. Bringing its characteristics to the management of agile projects, the application of BC in the Scrum process could contribute with the following capabilities:

- Decentralisation: the intermediation carried out by the PO could be replaced by BCT. In this scenario, the customer or some interested party could directly propose the elements to be included in the backlog. These would not be added to the backlog until all the stakeholders with acceptance role agree.
- Agility: meaning a faster response to the changing requirements

- Transparency: the communication of every change or action required by Scrum is provided in a natural way by the BC ledger.
- Accountability: keeping a complete record of all the developments carried out along the project, from its introduction in the backlog, through successive iterations, to its final functionality. Including the rejections or modifications suffered before their acceptance.
- Clear acceptance criteria based in Smart Contracts: the development is accepted when the conditions presents in the SC are fulfilled.
- Platform of trust: the combination of its main characteristics makes BC a network of trust even if the different parts are not known. This feature allows developments to be extended to unknown and off-site teams.
- Reconciliation: it would allow backlog elements to be extracted from different locations or teams, removing the possibility of doing duplicate work.
- In addition, if an SC-based reputation mechanism is implemented over blockchain, the tasks with higher value could be assigned to those in the team who have demonstrated greater reliability.

On the basis of the above, a proposal for the Scrum-Blockchain process is shown below.

**Scrum-Blockchain Proposal**

Blockchain could be established as the Scrum ledger, founding the base for agreements, accountability and as a value transfer platform during the development. Furthermore, it can serve as the basis for a reliable collaborative environment in which each stakeholder works together to maximize the value of the product or service.

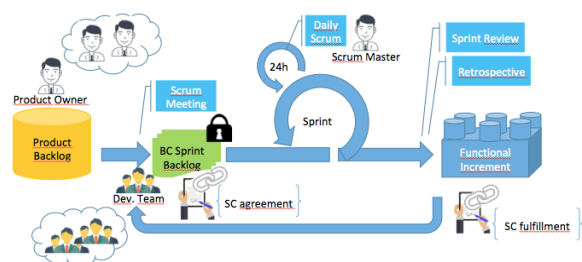


Figure 7 Scrum process with blockchain

In this case blockchain can be integrated inside the Scrum process as follows (Figure 2.):

1. The customer directly, or through an external PO, adds new feature elements to the backlog for the development of a product or service. These elements are not

yet accepted in the blockchain register, but they are shared with everyone involved (transparency).

2. The items of the backlog must include all the necessary requirements related with their implementation and verification. These attributes could be terms, conditions, priority, acceptance tests, remuneration value, cost of cancellation, temporal restrictions and others. Each functionality with its attributes will become a SC when it is registered in blockchain.
3. The development team, during the Sprint planning phase, will generate the list of elements of the backlog that will be developed during this iteration. These will not be executed if the customer or the external PO does not accept the package. When everybody involved agrees the proposal, the transfer is registered in the BC.
4. When the sprint is finished, it is verified that the generated release contains the new agreed functionality according with the acceptance terms and conditions present in the SC. If the contract includes transfer of value tokens, the owner of these items is transferred to the development team.

Using this technology the project implementation could be distributed among different development teams, outside firm or within the same organization. BC inside the sprint process could also act as a rewarding tool for the development team members. The sprint tasks could have a token valuation that a later could become a greater economic return or an improved reputation for a particular member of the team.

After each sprint, the BC database will include all the steps taken to complete it. This aspect will be of great importance for the customer and the PO as an accountability tool, and for retrospective meetings as a source of lessons learnt.

Having a blockchain network supporting the Scrum methodology can facilitate the development of agile collaborative projects, using it as the established tool for consensus on changes and priorities, as well as for the exchange of value and funding.

### 3.2. Kanban

It is one of the simplest agile methodologies with the highest speed of response to changes. It allows continuous integration of new functionalities in an changing environment with a high level of uncertainty in terms of priorities and requirements. Basically, it is a stack of tasks to be done sorted by priority and input order. Each member of the team is responsible for developing the next task present in the stack. When an item to be done is taken from the stack by a team member it is moved to 'in progress' state (Figure 3). The task is finalised when the specified requirements are met.

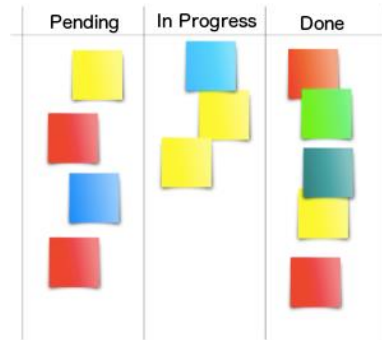


Figure 8 Kanban Board

### Advantages of Using Blockchain in Kanban

Blockchain will mainly bring the following characteristics to the Kanban process:

1. Immutable ledger: the tasks performed are accounted for.
2. Direct agreement between the owner of the task and the developer.
3. Automatic value transmission: it happens when the acceptance conditions present in the SC are fulfilled.
4. Expansion of the collaborative framework of the project: BC establishes a platform of trust, so that developers do not have to know each other or do the work in the same workplace.

### Proposal of using Kanban with blockchain

The Kanban methodology focuses on the work with the highest priority that has to be carried out. [6].

1. The pusher of the elements of the 'pending' stack introduces them by priorities, with their criteria of acceptance and their value in tokens. These have not yet been accepted for development so they are not committed into the BC ledger. As soon as they are proposed, every member of the blockchain network will be notified.
2. A developer proposes the implementation of one of the tasks in the stack. This is only authorized and registered in the BC network when both, the sender and the developer, accept the conditions (validating nodes).
3. When the work is finished and the acceptance criteria are verified by the SC the value tokens go to the developer.

When a task is completed, the developer extracts the next highest priority item from the 'pending' stack again

### 4. Discussion

The development and use of agile methodologies in different areas has led to their optimization at the

process level and in the behaviour of working teams [8]. However, in other areas such as governance, scalability or decentralization of working groups, there is still plenty of room for improvement. In fact, the application of these techniques in large projects, or in developments involving geographically distributed teams, is one of the greatest challenges today. [3].

This is one of the aspects where the application of blockchain technology can make a difference, bearing in mind that one of the great challenges today is to scale agile methodologies to distributed environments to achieve better and more efficient products or services [4]. Agile frameworks are based on direct communication and team spirit, and this is difficult to achieve in distributed environments. Without transparency, agile developments cannot bring projects to success [3]. Issues such as cultural differences, management of agreements and requirements, or issues of trust [4] and transparency can be addressed and resolved through the BC platform.

Moreover, having born as a decentralized value exchange mechanism, blockchain can be used as a reliable system for payments, financing and reputation between the client and the work teams.

The relationships between the different stakeholders can be articulated nimbly by translating them into SC. They can be converted into flexible contracts depending on the progress and needs of the project during its evolution.

On the other hand, it will be necessary to take into account the problems that the use of BC may have at present: implementation, implantation, regulatory framework [9] and cultural change, among others.

## 5. Conclusions

Throughout this article, several points have been identified in where BC can contribute with its strengths and capabilities to agile methodologies. Two different application cases have been considered: Scrum and Kanban.

The main advantages that BC provides, such as security, trust, disintermediation and transparency, have led to its successful use in distributed collaboration environments and in value exchange operations. The application of a BC platform in agile methodologies could make possible to scale the developments to decentralized teams, eliminating the existing barriers such as the lack of trust between the parties and the management of the agreements. This mechanism not only would increase collaborative capabilities, but it also would decrease the time between changes in requirements and the response from different development teams, improving the adaptability level, one of the main targets of agile project [6].

In addition, the natural mechanisms of BC in terms of value transfer, both tangible (e.g. monetary) and intangible (e.g. reputation) can automate economic exchanges and optimize the selection of work teams for the development of certain functionalities. Payments can be pre-arranged in SCs and

executed when the different stages: sprints, stories or tasks are fulfilled.

Throughout the project, the data, agreements and changes in requirements will be present in the blockchain network in real time, providing full transparency and maintaining a complete and auditable record of the project, its course and operations. Due to the immutability of the BC ledger it will make the recorded data totally trustworthy.

Having a BC platform within the project management framework will open up the collaborative world. Not only facilitating working within large projects in the same company, but also by extending the possibilities across organisations sharing different development teams.

During the development of this article, new questions and research topics arise, such as those referring to the analysis of the type of SCs that should be developed in order to apply them to the specific needs of agile project management, and the impact that the application of this type of technology can have on the agile management itself.

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# A proposal of project typology based on its relationship with sustainability

Ángela Paneque de la Torre\*, María-José Bastante-Ceca, Salvador F. Capuz-Rizo

\*anpade@doctor.upv.es

Universitat Politècnica de València

## Abstract:

**Sustainable project management is a great opportunity to face one of the most important challenges of our days: sustainable development. Former reviews show a growing trend in the number of academic publications on the topic of sustainability and project management [1]–[3]. They also show a focalization on the integration of sustainability into the processes, methods and practices of project management.**

**All the projects contain, to a greater or lesser extent, aspects related to sustainability. These aspects are manifested differently in each project. In order to understand how project managers manage the sustainability of a project, before it is necessary to know the types of projects that are managed in terms of their sustainability [4].**

**This work develops a proposal of project typology based on its relationship with sustainability.**

**Keywords: project typology; project sustainability; sustainable project management.**

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## 1. Introduction

The transition from our current form of development to sustainable development requires a great change in the way we produce, consume and even think and live. A more sustainable society requires projects to implement sustainable change [5]. Organizations, as part of society, are increasingly keen on including sustainability in their business, and project management can help make this process a success [1].

The integration of the concepts of sustainability into project management is an emerging field of study [6]. Previous literature reviews show an upward trend in the number of academic publications on the topic of sustainability and project management, especially since 2010 [1]–[3]. Based on a review of the emerging publication on sustainability in project management, [2] even concluded that the integration of sustainability into projects introduces a new school of thought in project management.

Despite the growing literature base, sustainable project management still lacks a precise typology of projects regarding their relationship with sustainability. According to [7], many contingency factors such as complexity, uncertainty, risk, project institutional environment, urgency, team empowerment, and criticality, have been introduced to classify projects. Researchers have also adopted management and economic theories to classify projects into homogeneous categories. The review of Niknazar and Bourgault [7] shows that for the same samples of projects, each theory or school of thought can potentially create a different classification scheme.

In order to understand how project managers manage the sustainability of a project, it is

necessary before to know the types of projects that are managed in terms of their sustainability [4]. As indicated by [7], by limiting the scope to specific project types, the project management principles, tools and methods applied are also adapted to the types of projects.

Therefore, this study proposes a project typology based on the relationship between projects and sustainability. This typology provides ideal types of projects. Each ideal type offers an abstract model, so that deviations from the ideal type can be observed and explained in real projects.

## 2. Background: typologies

Typologies are tools to interpret and understand the reality. According to [8], typologies are a very popular form of theory that appear to provide a parsimonious framework as well for describing complex organizational forms and for explaining outcomes such as organizational effectiveness. The main thesis of [8] is that typologies are complex theoretical statements that should be subjected to quantitative modeling and rigorous empirical testing.

The terms “classification” and “typology” are frequently misunderstood and/or used interchangeably in the project management literature [7]. [8] provided the following clarifications to reduce the confusion: “Classification scheme and taxonomy refer to classification systems that categorize phenomena into mutually exclusive and exhaustive sets with a series of discrete decision rules”, while “typology refers to conceptually derived interrelated sets of ideal types”. Typologies identify ideal types, each of which represents a unique combination of the attributes that determine the relevant results.

Typologies allow to better manage diversity [9]. Despite the uniqueness of projects, which is an essential characteristic of projects according to the main international standards ([10], [11], [12]), a typology can help to select the most suitable response to manage them. In other words, thanks to the development of a typology, the project management principles, tools and methods, can be better adapted to each type of project.

In spite of being helpful, few studies in the project management field have developed a typology for various dimensions of projects [7].

These typologies are valuable research studies in project management, but they do not explicitly show their conformity with the definition of a fully developed typology [7]. [8] asserts that there are at least three primary criteria that typological theories must meet: "(a) constructs must be identified, (b) relationships among these constructs must be specified, and (c) these relationships must be falsifiable". Moreover, they present a set of guidelines to improve the development of typologies:

- Typological theorists should make explicit their grand theoretical assertions.
- Typologies must define completely the set of ideal types.
- Typologies must provide complete descriptions of each ideal type using the same set of dimensions.
- Typological theories should explicitly state the assumptions about the theoretical importance of each construct used to describe the ideal types.
- Typological theories must be tested with conceptual and analytical models that are consistent with the theory.

[7] propose the typology of projects developed by [13] as a good example of a complete definition of a typology. Their research consisted of three phases. First, they introduced a basic conceptual, two-dimensional first-order construct for the classification of projects. Later, they analyzed the qualitative data of a field study of 26 projects, obtaining a set of "ideal types". Finally, they analyzed a second data base created by information obtained on 127 projects via structured questionnaires. This phase produced the quantitative modeling and the empirical testing of actual projects, and it demonstrated variants in the independent variables used to describe the ideal types.

Adopting the three-phase research developed by [13], this study develops the first phase to propose a new typology for projects from a sustainability approach, an emerging area in project management.

### 3. The conceptual model

The development of a typology starts with the identification of important dimensions or first-order

constructs. In the case of the different kinds of project according to the relationship between projects and sustainability, we select three first-order constructs: the nature of the object of the project dimension, the impact of the project dimension and the project life cycle dimension.

#### 3.1. The nature of the project object dimension

The object of a project can be focused on sustainability or not. Regarding this attribute, we have two types of projects:

Type 1: Sustainable projects by definition. The object of the project is focused on sustainability. This kind of projects includes that which outcome is a product or service aimed at improving the sustainability of the environment or human life. For instance, projects pointed to generating clean energy or protecting natural resources can be considered sustainable projects by definition.

Type 2: Projects in general. The object of the project is not focused on sustainability. This group includes projects in which outcome is not a product or service aimed at improving the sustainability.

#### 3.2. The impact of the project dimension

The PM<sup>2</sup> methodology [10] defines the impact of a project as "the measure of the effect of a project (permanent or temporary changes) on the organisation (processes, policies, technology, culture and people) or on the external environment". Two types of projects are defined based on the previous attributes:

Type 3: High impact projects.

Type 4: Low impact projects.

#### 3.3. The project life cycle dimension

Depending on its characteristics, the impact of the project can be produced by the project outputs (deliverables) or by the project outcomes (result of the deliverables).

Type 5: Project outputs impact

Type 6: Project outcomes impact

#### 3.4. Three-dimensional typology

The combination of the three first-order construct results on a three-dimensional framework with eight different types of projects, of which six ideal types are described (Figure 1).

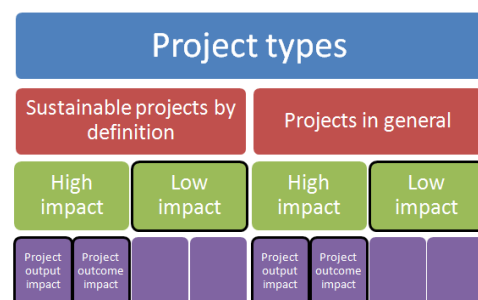


Figure 1. Project types from a sustainable approach

According to [8] guidelines, the typology must provide complete descriptions of each ideal type using the same set of dimensions. In this case, the dimension selected or second-order construct to describe each ideal type, is the sustainable role of the project manager. The role of the project manager changes as the focus on sustainability changes [4]. Moreover, different roles have different responsibilities for sustainability [14]. The sustainability effort of the project manager of a project is directly related with the sustainable nature of the object of the project. In the other hand, high impact projects have usually more management attention than low impact projects [9] and, although management attention “does not guarantee the availability of other resources like funding, people or equipment, its absence is a sure reason that these other resources will also not be available for the project”.

#### **3.4.1. Sustainable projects by definition – high impact – Project output (deliverable) impact**

The nature of the project, as well as the sustainability awareness of the project sponsor, influences the entire project team. So the sustainability effort of the project manager is lower. Sustainability has a high weight in decision making. High impact produces high management attention.

#### **3.4.2. Sustainable projects by definition – high impact – Project outcome (result of the deliverable) impact**

The sustainable nature of the project, as well as the sustainability awareness of the project sponsor, influences the entire project team. So the sustainability effort of the project manager is lower. Sustainability has a high weight in decision making. High impact produces high management attention. The project manager partially transfers the responsibility for sustainability to the project user, so this must have an important weight in the stakeholder analysis.

#### **3.4.3. Sustainable projects by definition – low impact**

The sustainable nature of the project, as well as the sustainability awareness of the project sponsor, influences the entire project team. So the sustainability effort of the project manager is lower. Sustainability has a high weight in decision making. Low impact supposes an additional effort to obtain management attention and resources for sustainability.

#### **3.4.4. Projects in general – high impact – Project output (deliverable) impact**

The sustainable nature of the project, different of the sustainability, makes the sustainability effort of the project manager higher. Sustainability has a low weight in decision making. High impact produces high management attention.

#### **3.4.5. Projects in general – high impact – Project outcome (result of the deliverable) impact**

The nature of the project, different of the sustainability, makes the sustainability effort of the

project manager higher. Sustainability has a low weight in decision making. High impact produces high management attention. The project manager partially transfers the responsibility for sustainability to the project user, so this must have an important weight in the stakeholder analysis.

#### **3.4.6. Projects in general – low impact**

The nature of the project, different of the sustainability, makes the sustainability effort of the project manager higher. Sustainability has a low weight in decision making. Low impact supposes an additional effort to obtain management attention and resources for sustainability.

## **4. Conclusions**

This research aims to extend our understanding on the characteristics of the different types of projects a project manager can find from a sustainable point of view. Each type of project will need a different approach to be managed.

This study develops only a first step to propose a new typology for projects from a sustainability approach. This first phase consists in defining completely the ideal types and providing complete descriptions of each ideal type using the same set of dimensions.

Future research could be focused in obtaining and analyzing information from real projects in order to check and compare the variables used to describe the ideal types.

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# Competence Management for the digital transformation in German SMEs

Nargiza Mikhridinova<sup>\*af1</sup>, Carsten Wolff<sup>2af1</sup>, Andreas Franke<sup>af2</sup>  
\* nargiza.mikhridinova@fh-dortmund.de

Af 1: Dortmund University of Applied Sciences and Arts  
Otto-Hahn-Str. 23, 44227 Dortmund, Germany

Af 2: mpool consulting GmbH, Joseph-von-Fraunhofer-Str. 20, 44227 Dortmund, Germany

## Abstract:

Today the concepts of digital transformation are highly discussed in the society. Digital transformation can be considered as a project which demands certain competences to drive it, including change management since it can be considered as a change project. For many German small and medium-size enterprises (SMEs), “Industry 4.0” is the path through the digital transformation. Therefore, it is a focus of a big number of researchers, entrepreneurs and companies, who want to digitally transform their business to stay competitive in a fast-changing environment.

Competences for the digital transformation and competence management have been identified as key success factors for mastering the digital transformation. This is reflected by the state of the art and by analysis of the case studies of two service-providing companies (German SMEs) concerning the way they go digital. Interviews with employees and the observation of workshops indicate that the main challenges the companies face are resulting from the organizational perspective, business process redesign and the required competences to drive the digital transformation.

**Keywords:** *digital transformation, business process analysis, competence assessment, change management, German small and medium-size enterprises*

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## 1. Introduction

The number of small- and medium-sized enterprises (further on: SMEs) in the German state of North Rhine-Westphalia makes up to 99,5% [1] out of total number of enterprises in the region. At the end of 2017 the amount of SME's workers counted 70,4 % of total number of employees in Germany, what is by 1,3 % higher comparing with the previous year [2]. That makes SMEs the backbone of the German economy driving societal development and offering huge numbers of working places, and this tendency seems to be expanding with time.

One of the factors providing growth opportunities to SMEs is digitalization, what is claimed as a “driving force” stimulating investments into enterprises development [2].

For technology driven German SMEs, digitalization in combination with automation and robotization is consequently connected with the Industry 4.0 phenomenon. The need for companies to step into next level of industrial revolution grabs attention of a big number of scholars [3].

Digital transformation for this type of companies is perceived as a reengineering of their core processes in combination with a full digitalization. The digital transformation is managed by projects and requires the right competences for change and transformation projects. Furthermore, companies combine changes in other areas (e.g. internationalisation) with reaching out into neighbouring business sectors (e.g. additional value added services). In combination with the new technical skills for the digital era this demands the

competences within the organisation to be managed in a new way [4].

The following section provides a brief literature review regarding the challenges of the digital transformation in German technology SMEs. The following sections describe the experiences of working with two SMEs on analysing their business processes, consulting on the required steps for digitally transformed processes and finally defining the competence development required for the transformation. The cases were conducted with a consulting company which helps SMEs to do the process reengineering for the digital transformation and to estimate the training demands for the staff.

The share of service-oriented companies among German SME's reached the value of 76 % in 2018 [2]. Therefore, it is important to analyse the state of the art of digital transformation in this type of companies. Both case studies considered further are represented by such service providers and reflect the challenges of SMEs being transformed digitally, especially regarding the required competence management.

## 2. Theoretical background

Since a term of “digital transformation” is quite new, it is essential to consider recent literature preferably written by German scholars to form a framework for further comprehensive research.

One of the prerequisites of literature research is to distinguish between terms of digitization, digitalization and digital transformation, which are often misunderstood as it was pointed out by [4]. [3, 5, 6] treat “digitization” as a synonym of Industry 4.0 and/or digitalization. The term of “digital



transformation” covers wider area like society, business reengineering and Industry 4.0 in [7, 8, 9], and the term “digitalization” more specifically was addressed in the literature analysing maturity level of SMEs within Industry 4.0 [3, 10].

In our paper we will focus on the term of “digital transformation” since we consider it an umbrella term reflecting the complexity of Industry 4.0 phenomenon.

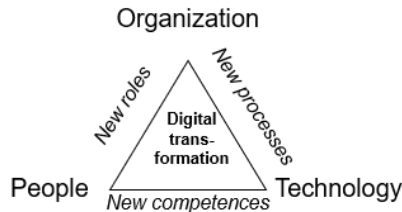


Figure 1. Triple constraints of digital transformation (based on [7, 11])

[3, 4, 7, 8, 9, 11, 12, 13] point out that digital transformation involves essential changes in entire business model, including IT-applications and organizational structure of the enterprise (Figure 1). Researches underline the interfaces existing between technology and organization when the new processes need to be established deploying new technologies. New technologies require new skills and enhanced knowledge how to maintain available tools. After the certain competences achieved the role of employee can / should be changed and reflected in the organizational structure.

[8] addresses the values of business process reengineering and redesigning of enterprise architecture for SMEs which transform digitally. It is common to follow a business process lifecycle: “discover – analyse – design – develop – deploy – operate – maintain”, when the process is discovered and analysed on the stage “as-is” process, then designed and developed into “to-be” process which afterwards is being deployed, operated and maintained and treated again as “as-is” process [14].

Several scholars [4, 7, 9, 11, 13, 15] specifically address competence requirements as a tool to drive digital transformation. Two of these studies as more valuable for the current paper can be explicitly mentioned in this chapter. [15] introduces competence management tool for SMEs which addresses current and future competences and discusses the ways to evaluate the gap between. And [13] represents comprehensive research study of Industry 4.0, conducted recently in Germany and addresses categorization of competences, allocation them to relevant roles in the organization and discusses the ways of further training/qualification of human resources.

The author of “Competency development for digital workplaces” [13] based on a systematic literature review and business case studies discusses possible scenarios, categorizing possible requirements for competences. Though the author underlines that the Industry 4.0 is only getting started and no conclusions can be drawn out of his research study, a description of future professional qualifications requirements provided by the author

can be seen as the most valuable in his research since it provides the first impression what competences will be needed for which roles in the future industry (Table 1).

Furthermore, among other challenges SMEs facing in terms of digital transformation, [16] underline the needs of organization to be externally supported to guide innovation processes. As that external support of organizational change and business reengineering processes, management consultants are claimed to be the important actors in fast changing environment [17].

Professional qualifications	Relevant roles in the company		
	Operators	Controllers	Maintainers
Combined mechanical, electrical, IT skills / knowledge		Programming skills in special software: •PLC, robot programs, CNC •Mechatronic systems •Networked systems thinking	
	Cross-functional knowledge: increase in demand for skills from related occupational groups for Electrical Engineers, Mechanics and IT specialist (programmer)		
Knowledge of networking technologies		Basic knowledge	Advanced knowledge
Knowledge of wireless and transmission technologies	Basic skills: •application understanding •control of behavioural requirements	Competences for the use of / wireless technologies (e.g., parameters setting)	Basic skills of high frequency
	Development of general and specific skills (e.g., RFID and wireless technology)		
Technical/ specific English knowledge	Basic knowledge for simple communication: reading and understanding of manuals	Internationalization of networks: •Communication competences on a technical level •Mastery of English knowledge to enable problem solving in foreign countries	
Knowledge of process engineering (materials)	Basic knowledge		

Table 1. Future professional qualification requirements (translated from German) [13]

### 3. Research methodology

The research method needs to be defined to confirm the next hypothesis:

- there is a competence gap which prevents SMEs from digital transformation.

As was mentioned above, the new technologies require new skills and hence new competences to align the processes with competences to maintain them.

The required new competences can be derived from the process analysis. The process at “as-is” stage shows the competence profile that the SME already has, and the process at “to-be” stage delivers the information about the new competence profile. The competence delta between future and present competence profiles can be derived from that and addressed via further analysis (training measures / assigning another employee to the role / hiring new employees, etc).

An inductive research method can be called in to confirm the hypothesis stated above. Listed below two case studies are supposed to generate the evidence and proof of the statement concerning the competence gap.

These case studies are introduced to analyse how German SMEs from service providing domain deal with digitalization and competence management in practice. The results presented were received from an internship research on the base of a consulting company in Dortmund [18] and consider several workshop sessions including interviews and information exchange between consulting company and SME's from North Rhine-Westphalia region, Germany.

#### 4. Results

On the one hand, SMEs face lack of resources to drive digital transformation projects by their own [10], on the other hand, German government sees SMEs as economy drivers [2] and is ready to invest and offer them various sponsoring opportunities.

One of these initiatives [19] provides a platform to create a network among all stakeholders influencing Industry 4.0 in the region. This kind of initiatives and other projects funded by the government entities of North Rhine-Westphalia enable SMEs to transform digitally in order to add more value to German economy and society.

The funding strategies offer SMEs to be consulted by project management entities, e.g. consulting agencies, with covering most costs of this cooperation. A consulting company is selected on a competitive base to run digital transformation projects with one or several SMEs of the region. The consulting company within the case studies [18] was selected to run such digital transformation projects with the two SMEs which are analysed in the case studies.

Following the traditional consulting approach [14], consultants need to evaluate the issues the company faces and find the appropriate way how it can be transformed via process analysis. It is made through collaboration with management entities of the consulted SMEs who has an authority to assign a responsible person for this cooperation. That employee(s) can be seen as a "change agent" who affect and enable change process [20] what makes this kind of partnership project part of change management knowledge area. Allocation of the "right" employee to the role of the "change agent" is a deciding factor in every change process [20], the same is for digital transformation in SMEs, since that person in cooperation with consulting company will enhance the motivational level of the colleagues to enable the change activities (*Figure 2*).

The next two cases are represented by service-providing companies, which are part of the cooperation project funded by German and European government bodies. This project emphasizes on the digital transformation of SMEs regarding assessing the maturity level of the company and competence requirements for the "as-is"-process and "to-be"-process.

#### 4.1 Case 1. Service provider company 1

The service provider company is a German process-oriented company, running the project in cooperation with the consulting company.

The aim of the workshop conducted with this company was to define the purchasing process at "as-is" level and define the level of digitalization of the process at "to-be" level.

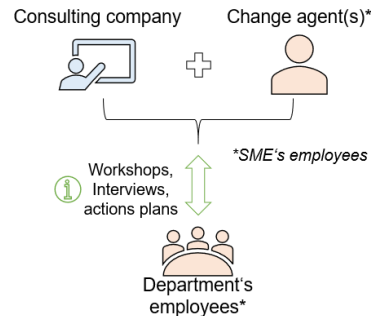


Figure 2. Model of cooperation (authors)

The moderator of the meeting played the role of a "change driver" in the company and served as a reference point to evaluate the readiness of the company to be transformed digitally.

A first step during previous sessions were brainstorming activities to define what processes should be improved with digitalization, what number of devices and which IT applications need to be implemented in the company.

For the second step a purchasing process was chosen as the most urgent to be transformed. After the interview sessions with employees, the need to transform the website for purchasing and the implementation of a customer relations management (CRM) system was identified.

The interviews showed that the employees had different perspectives on the digitalization process: if it was process- or outcome-oriented process, others struggled with changing activities. The lack of resources in SMEs makes the time devoting to transformation workshops / actions quite difficult, as well as employees do not share the same overall vision of the change process.

The reasons behind the different perspectives may result from different competence levels. As soon as the organizational competence and competence to conduct process reengineering activities of the employees is enhanced through previous training sessions and the values of the transformation process are communicated, the resistance overcoming will be accelerated.

#### 4.2 Case 2. Service provider company 2

This case introduces an international industrial manufacturing company from North Rhine-Westphalia on a different maturity level that is ready to take actions to be transformed digitally. The employees of the company were actively involved in the workshop and were willing to create an input for understanding what "as-is" processes they need to change and what competences were required for the transformed "to-be" processes.

Nevertheless, though it was not the first round of workshops, the participants were lost from time to

time: they could not fully understand how their “to-be” processes look like and what they need to achieve with that.

That underlines the competence gap the employees have, since they do not know how to conduct business process reengineering on the required level.

Further, during the workshop sessions, the employees managed to describe the “as-is” and “to-be” processes and derived the competence profiles based on the identified processes (part of results is presented in the *Table 2*).

Competence category	Requirements for “as-is-process”	Requirements for “to-be-process”
Technical product competence	Technical detailed knowledge according to software programs, basic knowledge of physics and engineering terms	Knowledge about product range and services, control & measurement technologies
Foreign language skills	Skills to manage E-mails and telephone calls in English; English technical terms knowledge	Relevant English electrical engineering terms knowledge

*Table 2. Results of competence profiles description*

These two structured competence profiles descriptions are demonstrating the awareness of employees of the required process changes, reasons behind it and all in all the readiness of the company to be transformed.

At the same time, this practical result represents the alliance with research “Competency development for digital workplaces” [13] regarding the groups of professional qualifications “Combined mechanical, electrical, IT skills / knowledge” and “Technical/specific English knowledge”. That proves that methodology of consulting company [18] approach is reliable and can be implemented further.

**5. Conclusion**

The case studies introduced the approach of defining the competence gaps through competence profiles description (Table 2), which was aligned with research conducted [13] in SMEs (Table 1). To fill these gaps the employees with the help of consulting company should determine the series of training measures defined on the next step of competences assessment via web-based tool “makom” [21].

Additional competence gaps were detected during the workshops concerning the lack of competence to conduct process reengineering. To fill that gap, the participants of the workshops need to have a pre-round of training to learn their processes in order to be able to do a comprehensive analysis of the “as-is” process and a proper design of the “to-be” process.

Comparing the results of both cases, it can be summarized that the second company finds itself on the different maturity level and hence better prepared for the digital transformation. The reasons behind this could be that this company has more resources than the first company for the transformation. The international culture of it makes the company open and less resistant to the change. The research conducted among current articles and studies on the topic lead to the conclusion that there

is a need for further research to find relevant theoretical framework to categorize competences for future implementation in practice.

The case studies prove the hypothesis only partially and uncover certain resistance areas:

- people are not willing to be involved into digital transformation activities and possible reason behind can be seen a loss of power or working place at all;
- people are not able to follow the change process probably because of lack of competences, e.g., reengineering or organizational competence;
- people do not know why and how to implement the change, probably in consequence of lack of information about what to do exactly;
- people are not allowed to perform the change process, possibly by reason of lack of decision making power or legal aspects in general.

Summing up the possible reasons, the human resources mostly face lack of competence and lack of willingness.

These blocks are needed to be investigated further through additional hypotheses statement and justification via holistic approach of literature research and empirical research methods like case studies analysis, surveys and new rounds of interview sessions with employees of German SMEs.

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# Managing stakeholder interests in the project of Christopher Columbus

Guillermo Montero  
[gmontero@us.es](mailto:gmontero@us.es)  
University of Sevilla, Spain

## Abstract:

From 1485 when Christopher Columbus arrived in Spain to 1493 when the Catholic Monarchs received him as admiral and viceroy of the new territories took place an interesting game of interests between different people, Columbus himself, the Castilian Crown and other European kingdoms, some monks and noblemen,..., that culminated finally with the Discovery of America. This historical period is analyzed as a case of study of project stakeholder management, which identifies several stakeholders who played a historical role in the voyage and brought to light different expectations of how they could influence the project.

*Stakeholder Management; Christopher Columbus; Discovery of America.*

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## 1.

### Introduction

There are many historical facts that offer clear examples of stakeholder management analysis. The case that is analyzed here focuses on the project of Christopher Columbus to open a new route to the Indies by the west and that closed with the discovery of America. This event can be considered as one of the most relevant events in history, allowing to connect in a stable and continued way two previously unrelated worlds.

Stakeholder theory shows that an organization, in our case a project as a temporary organization, has relationship with many people or groups and that can generate and maintain their support by considering and balancing their main interests [1], [2].

The concept of stakeholder management appeared in 1963 in the Stanford Research Institute, and related to organizational survival [2].

### 2. A game of interests before the journey (1485 – 1492)

Where Christopher Columbus was born is not clear at all, but it is not relevant for this analysis. He arrived in Spain in 1485 from Portugal, where he unsuccessfully proposed his project to John II in 1483. Columbus sought sponsorship from the Catholic Monarchs to open a new route to the Indies, Cathay and Cipango by the west. This arduous task lasted seven years, until 1492, when he “discovered” it. While his brother Bartholomew was commissioned to do so in his name, first to the Court of England, and then in the France. Both Henry VII of England, and Charles VIII of France rejected the proposal, or at least did not give approval on time. The magnitude of the enterprise was needing the support of the highest level; nobility was not sufficient for the purpose [3].

Despite this the most important Andalusian nobles, such as the Duke of Medina Sidonia or the Duke of Medinaceli, were interested in project of Christopher Columbus. The reason was that the main ports in the region were under their control [3]–[5]. The domain over the homeport allowed access to a series of benefits over the discovered or conquered territories.

The historical period in which we are in takes place after the Hundred Years’ War, and the beginning of the decline of the Holy Roman Empire and above all, after the occupation of the Ottomans in Constantinople in 1453 [6], [7]. This is a fact of special relevance, blocking the Silk Road to China, India and Japan. In this time, Portugal sought to reach the Indies by a new route around Africa. In fact, in 1488 Bartolomeu Dias reached the Cape of Good Hope, that opened the route to Asia.

Portugal and Castile signed in 1479 Alcaçovas Treaty, which was confirmed in 1481, with the papal bull *Æterni regis*. This treaty granted all lands south of the Canary Islands to Portugal. That means, all the lands discovered later by Columbus, could be considered to belong to Portugal. In theory we should consider that the existence of land west of Europe was unknown at this time [8].

Some authors argue the theory of previous contacts by Columbus, with an anonymous sailor [9] or the theory of the meeting with native Americans [10]. The knowledge of the existence of lands or islands in the west could be another aspect that influenced the project and this point were included in the scope of the project, and it were reflected in the Capitulations of Santa Fe [11].

The most significant people in Columbus’ project related to his project at this period were two monks, Fray Antonio de Marchena and Fray Diego de Deza. Probably the only ones who knew completely his

idea. In fact, the first one appears in all correspondence between Columbus and the Kings [12]. According to several points of view, he could even be considered as a project manager [3], [11], [13].

The first meeting between Christopher Columbus and the Catholic Monarchs happened in 1486 in Alcalá de Henares, thanks to Franciscan monks Juan Pérez, Hernando de Talavera, the queen's confessor, and Antonio de Marchena. From the onset Queen Isabella was interested in Columbus' proposal. After several meetings, including some in which the project had been rejected, Isabella postponed it because of the Conquest of Granada. All the proposals were submitted to a committee of experts, who dismissed them because of feasible reasons. Isabella was interested in the project from the beginning, supporting Columbus at certain times, while Ferdinand did not take part.

The key role in the project by King Ferdinand and the Crown of Aragon are clearly reflected in the involvement of his main collaborators: Juan de Coloma, notary of the kingdom of Aragon, and Luis de Santangel and Francisco Pinelli, both baptized Jews, who were responsible for the treasury.

The situation of Jewish people at that time should be taken into account. The Spanish Inquisition was founded by the Catholic Monarchs in 1478 in order to maintain Catholic orthodoxy in their kingdoms and its persecution of Jews began in 1491, when the first sentences to the bonfire occurred. The pressure of this court, the continuous denunciations and accusations about Jews and new Christians, as well as the executions that it exercised allow to identify possible interests of many of the characters. Three months later the Conquest of Granada, the kings decreed the expulsion of Jews. This becomes effective just before the start of the Colon journey. It is estimated that one third of the trip's crew members were Jews or descendants of Jews [14].

Once were expelled the Muslims from the peninsula, the growth of the Crown of Castile expanded towards the Atlantic, while the Crown of Aragon concentrated its efforts on the Mediterranean. A potential route to the Indies by the west allowed Isabella and Ferdinand to lead the political and economic position against the rest of European kingdoms and maintain the internal balance between Castile and Aragon.

Just after the Conquest of Granada, the Catholic Monarchs, probably by Ferdinand initiated, and Columbus signed the Capitulations of Santa Fe on April 17, 1492. This document consolidated the aspirations of the discoverer and gave him great benefits in political and economic terms in the case of success. The details were inscribed in the register of the Crown of Aragon.

As is shown before, from the point of view of the Crown, the port of departure had to belong to it. For this reason the Catholic Monarchs bought half of the

villa of Palos in June of 1492 [15] and the expedition had to sail westward out of the Canaries.

Bear in mind the financial point of view, the project budget was more than 2,000,000 maravedis. Luis de Santangel as well as Francisco Pinello gave 1,400,000 maravedis from the Treasury of the Holy Brotherhood. Some Genovese investors contributed 250,000 and Santangel himself provided 350,000 maravedies [3]. But also, as Santangel and Pinello were from a converted Jewish family, their participation would mean in the recognition of "old Christians" for them and their families.

### 3. Interests during the journey

On May 23 Columbus presented the project to the people of Palos, but he did not convince anyone. The town had to build two caravels (the sailing ships to be used) by orders of King and Queen and make them available to Columbus [3].

The support of the Franciscan monks Antonio de Marchena and Juan Perez was essential in the introduction to the sailor, Martin Alonso Pinzon (the other important person of the first trip to America). Pinzon, born in Palos, supported Columbus from the first time they met and then convinced a crew of expert sailors to take part in the project. The Pinzon brothers were responsible for the administration of the enterprise and armed ships and recruited the crew, even ahead of receiving money [3].

It is important to consider the ownership of the ships, which were seized by the crown for the company, and the crew. The nao Santa Maria was owned by the Cantabrian sailor Juan de la Cosa, resident in El Puerto de Santa Maria, which in turn was a town dependent on the Duchy of Medinaceli. He was also the master of the ship and Christopher Columbus the captain. The caravel La Pinta was owned by Cristóbal Quintero, who embarked on his ship as a simple sailor. The captain of this was Martín Alonso Pinzon and the master his brother Francisco Martín Pinzon. Finally, the other caravel, La Niña was owned by Juan Niño, who acted as master and the captain was Vicente Yañez Pinzon [3].

On August 2, Columbus ordered the crew to board. The next day set off to the Canary Islands, which was required to catch the northeast trade winds. The stay in the Canary Islands lasted from August 9 to September 6, while repairing La Pinta. There was talk of sabotage by its owner, Cristobal Quintero.

The second stage of the journey was completed on October 12, although the last few weeks had been particularly difficult. A key figure at the time was again Martin Alonso Pinzon. He convinced the crew against several mutinies, although he also had his disputes with the Admiral.

The relationship with Christopher Columbus changed after the discovery, so that Martin Alonso managed his ship in different territories, discovering

gold in north of the island of Santo Domingo. He was reunited with Columbus, who had been shipwrecked in Santa Maria and they started the trip back together. Due to climatic conditions, the arrival to Old Continent did not coincide in time. Martín Alonso, in La Pinta, arrived at the Galician port of Bayonne on March 1, 1493, where he informed the kings of the success of the trip and asked for an audience, perhaps attributing to the discovery and this request was rejected. Columbus, in La Niña, on March 4 arrived on the Azores and a few days later to Lisbon, where he sent word of the results of his journey to King Juan II. The final destination of the journey was the port of Palos, where the admiral arrived first, on March 14 and the following day Pinzon, who dies of syphilis shortly after.

#### 4. Conclusions

As we have seen that previously, the journey of Columbus, especially during the previous stage that the navigator spent time in Castile, we can analyze it as a clear case of project stakeholder management. Although we are unable to know when Christopher Columbus initiated the project, probably during his stay in Portugal between 1483 and 1485 we do know that closed with audience with the Catholic Monarchs in Barcelona in April 1493; where he was received as admiral and viceroy of the new territories, meeting all his expectations.

In our opinion, the role of the project is always attributed to Columbus, but there is a figure who plays a role that is of the same importance. This person was Fray Antonio de Marchena, who from having knowledge of the company, allowed the project to develop until its closure. The enterprise took place by the confluence of the interests of its promoter, Christopher Columbus, members of the clergy, such as Fray Juan Perez, Fray Hernando de Talavera or Fray Diego de Deza, interested in expand the Christianity to new territories, the Catholic Monarchs, as heads of the Kingdom of Castile, who were the legal guarantor, and different people of the Castilian Nobility, represented the political and military power.

In addition, the Pinzon brothers played an important role in the preparation of the navy throughout the trip, both technically and through the management of the crew.

The sponsorship of the project was supported by Queen Isabella, in the pre-trip phase, but it was King Ferdinand who finally decided on its execution.

What draws attention to the interest are the people from the Crown of Aragon and, above all, the financial support was given especially by Luis de Santangel, and Genoese investors, which were linked to this crown.

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# Gamification of Software Development Projects: A Six-Step Approach to Add Value to Businesses

Areej Aldaghamin\*, Ala Nuseibah\*\*

\*areej.aldaghamin@fh-dortmund.de, \*\* ala.nuseibah@fh-dortmund.de  
University of Applied Sciences & Arts Dortmund, Otto-Hahn-Strasse 23, 44227 Dortmund, Germany

## Abstract:

One of the crucial aspects of project success is having an engaged, motivated team, especially in software projects because of the rapid changes and the nature of the work. Gamification shows successful results in education and health; newly its application has also proved beneficial to businesses. The primary goals of using gamification are to add interactive, fun elements to routine team tasks to enhance the sense of motivation, enjoyment, engagement, and commitment [10]. In this paper, we will study why embedding gamification in the work environment is an added value to the management and development teams of software projects in IT companies and examine its application. To achieve this, we present a six-step approach to gamify software development tasks, reflecting on its benefits from the perspective of management and employees.

**Keywords:** *Gamification; Project management; Team management.*

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## 1. Introduction

Every project is constrained by time, cost and quality [1]. One of the crucial aspects of project success is having an engaged, motivated team [1]. Leading organizations nowadays use game elements and point-systems to create a positive, competitive environment between their employees, understand the performance of teams and individuals and find out ways to enhance it [2].

This process is called “gamification”, which means adding game elements to a new system or an existing one, creating fun elements which in turn enhance the user experience. The user concerned in this context is the employee.

This is especially needed for software development projects, where people management has been considered a key concern (DeMarco and Lister, 2013) [3]; and has been cited in various reference models such as the People Capability Maturity Model Curtis et al., 2001, and Team Software Process [4]. Adding gamification can make a positive and huge influence on the motivation of the employees inside the software and can help management teams assign resources more efficiently, manage tasks and schedules and evaluate the team and individual performance more accurately.

This paper aims to provide insights on how gamification of the development process benefits the people management and performance of team members in software development projects. The research is based on a critical review of available resources and adaptation of game-thinking models to the development process of software projects.

## 2. Methodology

This paper relies on a thorough review of literature resources on the topic of gamification and project management, and then specifically the gamification of software development projects. The review identifies gaps in literature when it comes to software development as an application field. It also shows that the focus in the current work is on measuring the benefits of gamification through quantitative measurements that reflect users' performance and productivity.

However, these fail to notice many qualitative aspects such as task complexity, work environment and the less obvious benefits of gamification such as those benefits to team behavior, engagement, and motivation. To address these gaps, the authors select the 6-step approach to gamification proposed by Werbach and Hunter [5] and apply it to the development process of software projects. Therefore, the contribution of this paper lies in a step-by-step approach to gamifying the development tasks in a software project, highlighting the benefits gained for employees and management.

## 3. Related Work

Besides the manifold work on gamification in general and for specific applications, e.g. in education, there has been rising interest in research on gamification in software development. However, gamification studies are still a new trend, and according to many researchers [9], it is not that easy to find relevant publications or articles on this topic. It is also difficult to find contributions that highlight the application aspect of gamification in a software development environment, e.g. in the shape of a



real task management system that manages engineers using gamification technic.

Hamari et al. [7] define gamification as enhancing user interaction with any system and providing the user with achievable, daily challenges to make them feel more engaged.

Unkelos-Shpigel et al. [6] categorize the users into pre-defined categories: the creators (architect, programmer, customizer), and the reviewers (architecture reviewer, code reviewer, tester). Creators are responsible for their work, and the reviewers give points for them.

Hamari et al. [7] perform a systematic literature review of empirical studies in the area of gamification and find that gamification produces positive effects on the users on three levels which are the “motivational affordances, psychological outcomes, and behavioral outcomes”. Those users in the context of software development projects they are mainly parallel to the role of “creators”, However, they emphasize that the effects are highly dependent on the context of the gamification and the users.

Another study that highlights the benefits of applying game elements is the work of Daniel and Giordano [8]. Their work is in the educational field and their focus is on students as creators of content. They explain the gamification process as a three-step approach:

- a. Analysis: searching for the best gamification technique in the available context/application
- b. Integration: selecting the best mechanism to introduce and integrate the selected gamification technique
- c. Evaluation: selecting a mechanism and a set of metrics to evaluate the final results of the different teams after the introduction of the game elements.

According to the authors, the analysis activity is the easiest one. However, the integration of the game elements within the context and applying it to achieve its purposes is a more complex task.

Similar to the work of Hamari et al. [7], the work done by Daniel and Giordano [8] shows that gamification has positive effects on the creators, students in this case, and on the outcomes. The productivity of the student teams who benefited from gamification elements in their educational experience was higher and their engagement and participation were improved. They explain this by pointing out that students track other students' achievements and this makes them more competitive and committed.

As for software development related literature, gamification is highlighted in the work of Erick et al. [10]. They propose a game design arranged in a challenge-punishment-reward loop that is decomposable, chainable and combinable; meaning the challenges given to “creators” need to be breakable into smaller, less complex tasks, progressively rely on each other and lead to a learning curve. Therefore, they see that the game

elements need to be organized as a set of ordered, hierarchical challenges often requiring several different skills from developers, and lots of teamwork effort to be overcome. From a “reviewer” point of view, the authors suggest easily measured quantitative metrics, such as lines of code, number of tasks completed, duration of each iteration, etc.

However, there are several shortcomings that can be observed in the related work:

- in contrast to what is proposed by Unkelos-Shpigel et al. [6], the gamification process should be easy, straightforward and should not create additional effort for either the creator or reviewer roles. It should also not change the current project management processes entirely as this could lead to project teams refraining from applying game elements. The focus should be on adding the elements as an additional layer and ensuring smooth integration.
- existing work in the area of gamification of the software development process focuses on quantitative measurements that do not necessarily reflect the complexity of the task performed or the quality of the work performed to complete that task. More research is needed to cover this gap.

This paper proposes the 6-step approach to gamification proposed by Werbach and Hunter [5] and applying it to the development process of software projects to contribute to the available body of knowledge and address some of the aforementioned shortcomings.

#### **4. Applying the six-step approach to gamification proposed by Werbach and Hunter [5] to Software Development Projects**

Gamification design is complicated and connected to many things, in gamification, the focus is to make the players more enjoyable in what they do and engaging in, as well, designer of the game need to study the players. Not only that but what gamification offers to add games elements outside the game industry which means to make the game for a purpose and this comes in the design stage of the game, includes designing the gamification elements and mechanics and the purpose of it.

Werbach and Hunter [5] propose a six-step approach to gamify any project as can be seen in diagram 1.

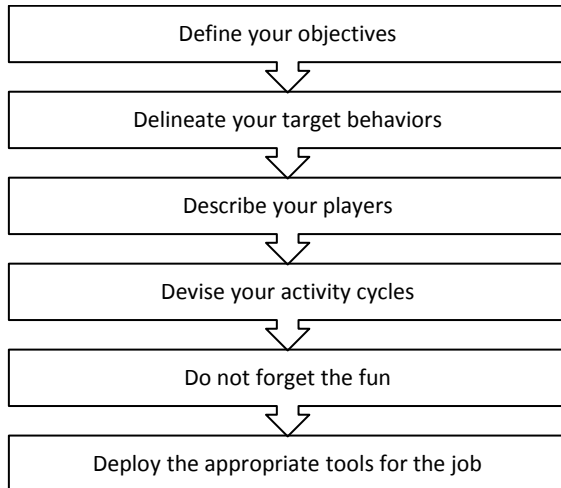


Diagram (1)

The authors use this approach to develop a step-by-step approach to adding gamification elements to the development process of a software project:

a. Define goals

In this context, defining the goals of the gamification comes first. The authors see that it is important to derive goals from two perspectives:

a.1. Developers / “Creators” Perspective:

gamification should improve:

- engagement and sense of “fun” during the implementation of coding tasks through creating gamified challenges.
- productivity
- developer’s own self-improvement by helping to recognize the weaknesses and strengths
- socialization between developers to complete the challenges
- sense of satisfaction with themselves and the team environment

a.2. Management Team / “Reviewers” Perspective:

gamification should facilitate and improve:

- evaluation of employees and teams’ performance in a project
- resource and task distribution
- understanding of the individual differences, skills, competences, and training needs
- a real-time view on the scheduled tasks and their progress
- predictability of the amount of time and resources needed for tasks and deliverables and therefore, improved project planning.

Those goals can be achieved over time and through several stages and gamification elements. The conflicts between goals, if any, should be resolved by setting priorities and starting with the highest priority goals.

b. Delineate target behaviors

The aim here is to answer the question: what behaviors are desired from the users of gamification and how can this behavior be measured? This means outlining desired behaviors and metrics to evaluate them.

On the side of creators, this could be in the form of

- increased willingness to learn, e.g. by attending more training courses
- increased willingness to cooperate with other team members, e.g. by the number of tasks performed by more than an individual
- increased productivity, which can be measured by the number of tasks performed, lines written, duration vs. complexity of tasks achieved
- increased satisfaction of users, which can be measured by surveys and feedback

On the side of reviewers, this could be in the form of e.g. reward systems.

Adjusting motivational levels and psychological outcomes should be considered within those target behaviors.

"Most project team members are motivated by an opportunity to grow, accomplish, be appreciated, and apply their professional skills to meet new challenges." [1]

In software projects, the new opportunities and challenges to expand work experience are the motivation points for developers. Seeking new skills is one of the most important goals for them on a professional and personal level.

Moreover, the point system achieved through gamification increases the transparency and accuracy of the team member evaluation. This increases team members’ creativity and sense of competition. After all, for every team member, it is important that their efforts are visible and valued in the organization.

c. Describe players

As we are specifically focused on the software projects our list of players that will be affected by gamification are the following:

- Developers/software engineers
- Team leaders
- Management team
- Human resource management

d. Devise the activity cycles

This step contains two steps, engagement loops, and progression stairs. As we are discussing software projects, we think that we can make the activity cycle by sprint which is not a long-term round and can give developers chances to improve on every newsprint which is between (3-4 weeks).

e. Don’t forget about the fun

One of the essential steps in the research is to provide immediate results for the user. The gamification layer should consider the capabilities of employees and the difference in experiences and abilities between them. Every user in the system needs to see feedback about their experience in the

system, the game has to give every user what an overview of what they achieved today and what areas of improvements are needed. For sure, rewarding is essential, even if it is virtual. We need to add challenges to our system to motivate the users with each other.

In this research gamification adding fun to the real work, games components are the fun-elements that can create the motivated developers to work and to engage more in the workspace, here is a shortlist and description of the most important game elements:

- **Points and Leaderboards:**

User points on the system mean what they achieved for the whole project time with their tasks, the points section could be variant between systems, but it is one of the main elements inside gamification and one of the most important elements in the feedback that where the developers see that they earn those points.

Erick, Danilo, Pedro, and Esteban explained that every system needs points as main elements of any game framework, the points section could be variant between systems, but still, it is one of the main elements of gamification. People like to get rewarded for what they do, and this is the reason that people like games a lot. Finding the right way to calculate points, will increase the user engagement with the system and enhance the life work. Leaderboards are for companies is the most critical area, because engineers like to challenge for a value. [10]

The results of the point evaluation are visualized on leaderboards, where every team member, category, effort and points achieved are viewed. This allows managers to gain quick insights into the progress of the tasks and an easily achieved evaluation of the achievements of every team member.

- **Achievements:**

Achievements also sometimes known as a trophy, badge, award, stamp, medal, challenge, represent the user accomplishments and performance, users or prefer to see results instantly.

- **Feedback:**

Feedback of every action and performance is needed in the gamified system. Every user should be provided of their achievements list and more details and analysis is required which is really important to understand the abilities and areas of improvement, also to show the level of improvement.

- **Rewards:**

Usually, companies have their rewarding systems and procedures, as we are not trying to change any of the existing processes of projects, we would stay with the existing rewarding system, however, gamification can support those decisions and procedures also adding more virtual rewards would create a positive feeling to developers.

- **Challenges:**

To add the concept of challenges to the elements of the game in our project is not easy and tricky. To motivate the users to be more competitive is a

double-edged sword. It is better to be used in specific events and not really for serious things inside the project to avoid any problems and frustrations.

- f. **Deploy the appropriate tools for the job**

We consider that the tools we will use to achieve the goals are using the task management system with integration with the code version control system used in the company additionally to other systems for example code analysis system, gamification elements will be added as a layer (Plug-in) to be shown in the same task management system that is used in the project.

## 5. Gamification and Team Management

Gamification influences not only the employees but also the managerial teams. Managers run several projects in parallel and have to consider aspects of cost, schedule, quality and customer satisfaction to ensure the success of their projects. As their work entails a lot of responsibilities, their ability to accurately control the progress of tasks and notice the efforts, achievements and professional development of each team member in the development team is limited. In addition to the limitation in the time that can be dedicated to planning social activities that increase the bonding and interaction among team members. Gamification saves, therefore, time and effort for the management team and provides results with higher accuracy. The game components, on the other hand, allow for the fun and social interaction between members of development teams.

Games motivate people to organize and manage their time and tasks, also create an environment for social life activities, developers will tend to communicate more personally or virtually.

At the same time, supervisors track every employees' performance per project, usually using reporting systems or simple reporting sheets. We think that the proposed solution is an excellent addition to this area. Not only that games make employees more active, motivated, social and competitive, but it can also affect management teams for a better and more clear understanding of the personal differences of the employees from a technical point of view even the abilities, the weakness and strength aspects of every single one of them.

Giving access to all the results data and the ability to view all details, from a manager perspective, can provide many benefits from the side of the status and distribution of the task, which reflects on the success of the project with fewer risks. From an employee perspective, many employees always complain about the evaluation and unfairness in the work, and adding gamification can be an added value to help to avoid such problems, and give more transparency between the employee and managers.

## 6. Conclusion and Outlook

Design and apply a gamification system for software management is not easy and straightforward, gamification could be a supporting tool for team management, especially in teams with diverse skills and personalities.

In this paper, we have introduced to the topic for software development projects, proposed an approach to embed and implement gamification elements into projects and reflected on the added value to the management and development teams.

The next step for this research would be completing implementing the plug-in linked with the task management system and to study more sources of data that can provide a more effective analysis of the results of the task, also more validation of gamification elements in more extensive tasks environments. To achieve that we will take a segment of managers and developers to interview them then improve our approach to reflect their real-life challenges and improvement suggestions. Further research is also needed to evaluate gamification design from both perspectives, developers, and managers.

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# How to optimize aerospace projects supply chain

Igor Ortiz Bilbao 1\*  
iobilbao@gmail.com

CT Asidek, Parque Tecnológico de Bizkaia, Laida Bidea, Edificio 407 – 2ª Planta, Zamudio, Bizkaia, Spain

**Abstract:**

In aerospace programs and projects, there are various supply chain risks arising from new product development and introduction. In this article we illustrate these new product development risks by using the case of the Boeing 787 Dreamliner. We had analysed Boeing’s traditional supply chain planning and new supply chain providers for 787 Dreamliner program. We consider key aspects for aerospace providers, when designing new supply chains for new products development and introduction. This approach can be instructive for managers of any industry, to view Boeing’s issue and learn from mistakes that were made before, when restructuring a supply chain for a new product development and introduction.

**Keywords:** aerospace project; project management, program, product development, risk management, supply chain.

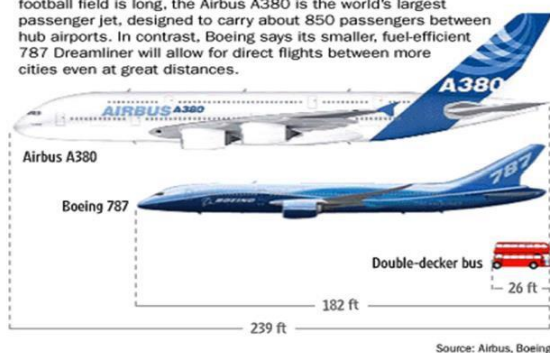
**1. Introduction**

In 2003 The Boeing Company decided to create value to its customers, the airlines by developing an innovative aircraft: the 787 Dreamliner. First, Boeing’s value creation strategy for the passengers was to improve their travel experience through redesign of the aircraft and offer significant improvements in comfort, for differentiating from competitors. For instance, relative to other aircrafts, over 50 percent of the primary structure of the 787 aircraft including the fuselage and wing is made of composite materials. As opposed to the traditional material (aluminium) used in airplane manufacturing, the composite material allows for increased humidity and pressure to be maintained in the passenger cabin offering substantial improvement to the flying experience. Also, light- weight composite materials enable the Dreamliner to take long-haul flights, enabling airlines to offer non- stop flights between distant pairs of cities without layovers, as preferred by most international travellers.

Providing midsize airplanes compared to big jets flying ranges while flying at approximately the same speed (Mach 0.85), Boeing value creation strategy is a game changing in new commercial airplanes. The midsize airplanes like 787 Dreamliner would allow airlines to offer economical non-stop flights and from smaller cities. In addition, with a capacity between 210 and 330 passengers and a range of up to 8,500 nautical miles, the 787 Dreamliner is expected to use 20% less fuel than existing airplanes of similar size. Due to composite advanced materials, new jet engines and 787 Dreamliner global design configuration, the cost per seat mile is expected to be 10% lower than for any other aircraft. Also unlike the traditional aluminium fuselages that experience metal fatigue. Dreamliner 787 fuselage is based on advanced composite materials which reduce airlines maintenance and replacement. As table 1 describes advantages of composites and new design concept in Dreamliner 787.

**Up, Up and Away**

Weighing in at 280 metric tons and with a wingspan as wide as a football field is long, the Airbus A380 is the world’s largest passenger jet, designed to carry about 850 passengers between hub airports. In contrast, Boeing says its smaller, fuel-efficient 787 Dreamliner will allow for direct flights between more cities even at great distances.



**Figure 1:** Comparison between Dreamliner 787 and Airbus A380. (Source: Airbus, Boeing).

The figure 1 compares an Airbus A380 with a Boeing 787 Dreamliner.

Feature	Values to airlines (immediate customers)	Value to passengers (end customers)
Composite material	<ul style="list-style-type: none"> <li>Fuel efficiency (lighter material lowers operating cost)</li> <li>Corrosion resistance (lower maintenance cost)</li> <li>Stronger components that require fewer fasteners (lower manufacturing cost)</li> </ul>	<ul style="list-style-type: none"> <li>Faster cruising speed, which enables city-pair non-stop flights</li> <li>Higher humidity in the air is allowed, which increases comfort level</li> </ul>
Modular design that allows for two types of engines (General Electric GEnx and Rolls-Royce Trent 1000)	<ul style="list-style-type: none"> <li>Flexibility to respond to future circumstances (market demand) at a reduced cost</li> <li>Simplicity in design allows for rapid engine changeover</li> </ul>	<ul style="list-style-type: none"> <li>Cost savings with cheaper and faster engine hangover may be passed on to passengers</li> </ul>

**Table 1:** Added value points in Boeing 787 Dreamliner. (Source: Boeing).

## 2. Background

Due to the unique value that the 787 provides to the airlines and their passengers, the number of orders exceeded expectations. The Dreamliner is the fastest-selling plane in aviation history with carriers attracted to its new largely composite design and innovative next generation jet engines that will allow to fly with less fuel. The Dreamliner program has been considered disruptive combining novel technology and production strategies. On November 16, 2008, Boeing had received orders from 7 airlines that accounted for 895 Dreamliner's. The overwhelming response from the airline industry to Boeing's 787 forced Airbus to quickly redesign its competitive wide bodied jet the A350, to make it even wider, which was later released as the A350XWB.

Besides airlines, the stock market also responded favourably when Boeing launched its "game-changing" 787 Dreamliner program in 2003. Between 2003 and 2007, Boeing's stock price increased from around 30\$ to slightly over 100\$. On the other hand, Boeing has had to announce a series of delays beginning in late 2007 to which the market has reacted negatively. The negative market response is expected as publicity of Boeing's supply chain issues become increasingly evident. Airbus shared a similar fate after announcing a series of delays for the delivery of its A380 aircraft in early 2006. Despite significant capital investment and management effort, Boeing has continued to face delays its schedule for plane delivery to customers. The 787 Dreamliner flight took place in December 2009 and Boeing began pilot training for the first customer, All Nippon Airways (ANA) in April 2011. This motivates to examine the underlying causes of Boeing's challenges in managing 787s delivery schedule.

## 3. Research method: actual aerospace project management

In this section a described view of Boeing's supply chain objective is described. The objective was to reduce development time for 787 from six years to four years and the development cost from \$10 billion to \$6 billion. Boeing decided to develop and produce the Dreamliner by using a new supply chain in the aerospace sector. The 787 supply chain was designed to keep the manufacturing and assembly costs down and spreading the financial risks of development to Boeing's suppliers, partner at risk new concept, figure 2 describes new supply chain for Dreamliner 787 aerospace program.

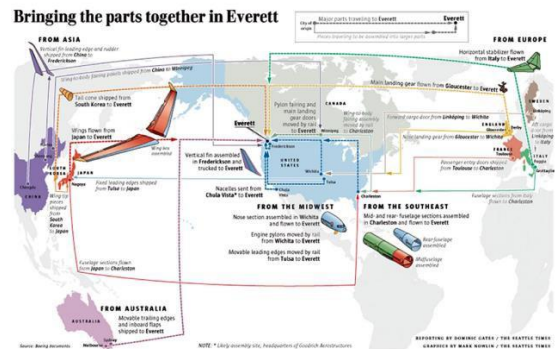


Figure 2: Boeing's global supply partners (Source: The Seattle Times).

Unlike the 737 supply chain that requires Boeing to play a key role. Boeing assembles different parts and subassemblies produced by thousands of suppliers. With new 787 supply chain structure would allow Boeing to be closer with his strategic partners. That are approximately 50 tier 1. Also in 787 supply chain structure, Boeing's tier 1 strategic partners are responsible for delivering complete sections of the aircraft. Allowing Boeing to assemble these complete sections in three days at its plant located in Everett, Washington. Attached a comparison table 2 between the two supply chain programs 737 and new Dreamliner 787.

Component	737 Program	787 Program
<b>Sourcing strategy</b>	Outsource 35-50%	<b>Outsourced 70%</b>
<b>Supplier relationship</b>	Traditional supplier relationship (purely contract)	<b>Strategic partners with tier-1 suppliers</b>
<b>Supplier responsibilities</b>	Developed and produced parts for	<b>Developed and produced entire</b>
<b>Number of suppliers</b>	Thousands suppliers supplying	<b>Approximately 50 tier-1 strategic partners</b>
<b>Supply contracts</b>	Fixed price contracts with delay	<b>Risk sharing contracts</b>
<b>Assembly operations</b>	30 days for Boeing to perform final	<b>3 day assembly of complete</b>

Table 2: Added value points in Boeing 787 Dreamliner. (Source: Boeing).

By outsourcing 70% of the development and production activities under the 787 program, as can be seen in figure 3. Boeing shorten the development time and development cost by leveraging suppliers' ability of developing different parts in parallel. As Boeing outsourced more, communication and coordination between Boeing and its suppliers became critical for managing the progress of the 787 development program.

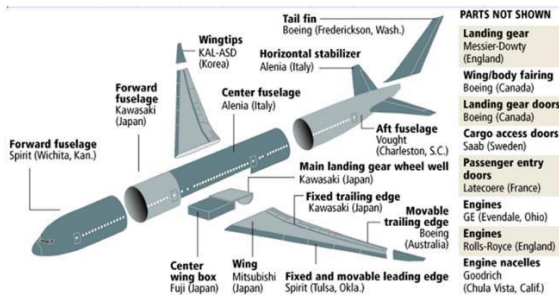


Figure 3: Dreamliner Tier 1 and Tier 2. (Source Boeing).

To facilitate the coordination and collaboration among suppliers and Boeing, Boeing Implemented the Exostar Supply Chain Systems powered by E2 Open software that is intended to gain supply chain visibility, improve control and integration of critical business processes, and reduce development time and cost. For example, when delivery problems arise with tier 2 suppliers, Exostar would alert the affected tier 1 partner. Then, if the situation is not resolved appropriately, Exostar would alert Boeing so that Boeing has the option of intervening directly to address the issue.

An example of traditional supply chain in 737 Boeing's program and new supply chain for the Dreamliner 787 program. As we can see in figure 4 Boeing deals with a high level of suppliers and just get part for their assembly.

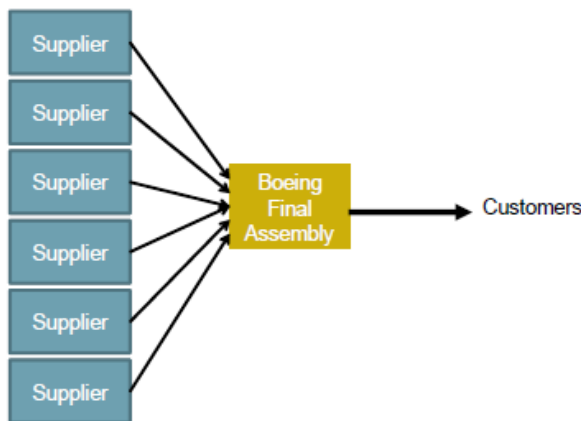


Figure 4: Boeing's traditional supply chain workflow (Source: Boeing).

With this supply chain method the assembly processes increase and costs rises. With the new supply chain methodology shown in figure 5 for Dreamliner 787 program Boeing's reduces assembly times and main supplier (tiers one and tiers two) these are more close to Boeing's integration supply chain network.

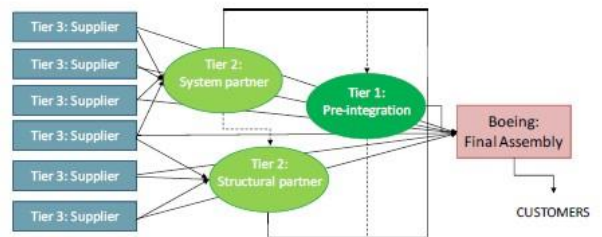


Figure 5: Boeing's new supply chain workflow for 787 Dreamliner (Source: Boeing).

This helps Boeing to anticipate in decisions if some supplier is not aligned with the program dates or is a time disorder. On the other hand the assembly time and cost are reduced, due to subassemblies and subsystems are sent to Boeing assembly lines directly.

**Result from aerospace project management**

With new supply chain methodologies Boeing would need only three days to assemble complete sections of the Dreamliner at its plant in Everett Washington. Relative to the 737 supply chain, this incredible reduction in production cycle time would increase Boeing production capacity without incurring additional investments. Attached in figure 6 a comparison between 737 and 787 Boeings aerospace programs, where can be seen the benefits of new supply chain model.

Component	737 program	787 program
Sourcing strategy	Outsource 35-50%	Outsourced 70%
Supplier relationship	Traditional supplier relationship (purely contract based)	Strategic partners with tier-1 suppliers
Supplier responsibilities	Developed and produced parts for Boeing	Developed and produced entire sections for Boeing
Number of suppliers	Thousands suppliers supplying directly	Approximately 50 tier-1 strategic partners
Supply contracts	Fixed price contracts with delay penalty	Risk sharing contracts
Assembly operations	30 days for Boeing to perform final assembly	3 day assembly of complete sections

Figure 6: Boeing's 737 and 787 programs comparison table (Source: Boeing).

**4. Conclusions**

The Boeing's 787 Dreamliner program had an impact in traditional supply chain strategy and methodologies. From traditional tiers that are time consuming and they do not support subassembly operations, this activities cost Boeing extra time and labour hours. It is instructive for managers in any industry to view the issues that Boeing faced to learn from mistakes that were made before engaging in similar supply chain restructuring for a new product. Some of these lessons are: Assemble a leadership team with requisite supply-chain expertise: fundamental problem was caused by its attempts to take on too many drastic

changes simultaneously: unproven technology, unconventional supply chains and unproven supplier's capability to take on new roles and responsibilities, and unproven IT coordination systems.

Due to customer airplane delivery dates, Boeing constituted a multi-disciplinary team with expertise in supply chain risks, Boeing could have avoided and anticipated potential risks, and developed proactive mitigation strategies and contingency plans to reduce the impact of various supply chain disruptions. Other important factor is to obtain an internal support proactively: partnerships between management and smooth operations for companies to implement any new initiatives including new product development programs. Must be a better communication of business strategies with production plants and assembly plants workers. These meetings with workers can avoid several costs in production lines, due to workers have a more clear view of the new program scenario. To improve the supply chain visibility for facilitating the coordination and collaboration. In these case Boeing must develop a strong commitment with its suppliers for accurate and timely information. This point requires a upgrade on IT communication, that is risky in a new project like 787 Dreamliner.

For mitigating possible risks caused by suppliers in the network. Any company should have enough visibility of the entire supply chain. With this capability the company is capable to take corrective actions in a short period of time reducing time and costs.

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