The Role of Business Process Modeling in Information System Development with Disciplined Agile Delivery Approach

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Abstract— **Agile approach to software development is formally established in 2001 with Agile Manifesto promotion. Many different methods of agile approach were used by practitioners for many years and the need for their integration and tailoring has emerged to new methodology created by IBM and promoted since 2012 as disciplined agile delivery approach. This paper aim is to describe the role of modeling in disciplined agile approach. A case study is presented with results of project of information system development within educational environment. Selection of models to be used for information system development within disciplined agile approach in this case study is oriented towards business process model, UML's use case model and data models. They are represented as a basis for agile software development and iterative delivery within the case study. CASE study is focused on the analysis of the impact of business process modeling to information systems software project performance within Disciplined Agile Delivery approach.**

I. INTRODUCTION

Evolution of software engineering [1] established paradigms and appropriate methods and tools, starting with 1950's (software engineering as hardware engineering), 1960's (software crafting), 1970's (formality and waterfall model), 1980's (productivity and scalability), 1990's (concurrent vs. sequential processes, open source development and usability). 2000's are characterized [1] by development of agile methods, value-based software engineering, model driven development and integration of software and system engineering and 2010's with globalization and development of system of systems.

Developers of agile methods established Agile Software Development Alliance [2] in February 2001 and signed document "Manifesto for Agile Software Development" [3] with 4 core values and 12 principles to follow in software development. This event is considered as a formal start of application of agile methods in practice. During the process of agile methods tailoring, different terminology from diversity of agile methods confused practitioners and incompleteness of particular agile methods required integration in their practical use and delivery of results [4]. Therefore, in 2012 IBM proposed [5] Disciplined Agile Delivery framework (DAD) as a process framework that is oriented to delivery of solutions by applying integration of different agile methods. "The Disciplined Agile Delivery (DAD) decision process framework is a people-first, learning-oriented hybrid agile approach to IT solution delivery. It has a risk-value delivery lifecycle, is goal-driven, is enterprise-aware, and is scalable." [4] Basic values and principles described in [5] are formulated as Disciplined Agile Manifesto (DAM) [6].

In continuation of our related research in information systems modeling ([7], [8], [9], [10], [11], [12]), with this paper we aim to investigate the role of modeling in information system development, within a context of disciplined agile delivery approach. Change in development paradigms and methodology directed to speed in solution delivery and stakeholders satisfaction minimize efforts and time spent on modeling. These changes enforce the need for research about the position of modeling in disciplined agile delivery as contemporary industry model. Results of this research could be basis for change in higher education of information systems and software engineering teaching plans.

Basic research question of this paper is: "What is the role of modeling within disciplined agile delivery in information system development?" This question could be elaborated with answering to particular, more precise questions: Is there a need for modeling within disciplined agile delivery in information system development? Since DAD methodology denote "initial modeling", which level of details is appropriate? Is there any particular type of modeling process and types of models in DAD methodology for information systems development? b) Which models are necessary (core)? c) Which models to use in aim to minimize time and efforts in creation of models? By selecting particular types of models, is the selection appropriate? b) Which criteria could prove that the selection of models is appropriate?

There are several feasible directions in choosing research methods regarding previously set research questions: analysis of related work in literature; conducting a survey in software industry, with questions regarding their attitudes regarding position of modeling in application of DAD and impressions about their experiences in this field; empirical research within a case study on application of DAD within educational environment, with students projects implementation. In

this paper, we choose empirical research as a case study on application of DAD within educational environment.

Second section of this paper represents background about disciplined agile delivery approach. Third section represents motivation for the research that is related to position of disciplined agile delivery approach in higher education. Fourth section is particularly related to research methodology for the case study empirically conducted at University of Novi Sad, Technical faculty "Mihajlo Pupin" Zrenjanin, Serbia. Fifth section represents results of case study and discussion about research questions and hypotheses. Final section represents conclusions regarding the role of modeling in information system development and possibilities of focusing on core models related to functional and data aspect.

II. BACKGROUND

The term "agility" is defined in [13], based on definitions from [14] and [15] as "an effective integration of response ability and knowledge management in order to rapidly, efficiently and accurately adapt to any unexpected (or unpredictable) change in both proactive and reactive business / customer needs and opportunities without compromising with the cost or the quality of the product / process". Agility is closely related to flexibility and leanness, but they should be distinguished (i.e. they are concepts within the agility as a broader term). Research [13] systematized 28 frameworks and models "describing the concepts that determine agility or at least proposed different items to measure agility." [13] These frameworks could be categorized in four domains: Agile Manufacturing, Agile Software Development, Agile Organization/Agile Enterprise and Agile Workforce and all of them together include 33 different concepts that are included in agility definition and frameworks. All these concepts could be categorized in 5 domains: organizational culture, technology, workforce, customer, organizational abilities.

Agile methods application in the first period of use (before establishment of Agile Manifesto) were sometimes considered risky, being interpreted as opposed to planned and predictive process models and, therefore, leading to chaos [16]. Both agile methods and plan-driven methods have home ground where they fit best [16]. Plan-driven methods characteristics: developers (plan-oriented, adequate skills); requirements (knowable early, largely stable); architecture (designed for current and foreseeable requirements); teams (larger teams and products); primary objective (high assurance). Agile methods characteristics: developers (agile, knowledgeable, collaborative); customers (dedicated, collaborative, representative, empowered); requirements (largely emergent, rapid change); architecture (designed for current requirements); teams (smaller teams and products); primary objective (rapid value). Hybrid approaches should be considered [16] in scaling between these two extremes [17].

During period 2006-2012, the Disciplined Agile Delivery (DAD) process decision framework was developed by IBM (Scott Ambler), as the result of the observations of different agile methods application worldwide [17]. Basic characteristics of disciplined agile delivery framework are [17]:

- Hybrid – using strategies from agile methods: Scrum, Extreme Programming (XP), Agile Modeling (AM), Unified Process (UP), Kanban, Outside in Development (OID), and Agile Data (AD) etc.
- Enterprise aware – "Disciplined agile teams recognize that they are part of a larger, organizational ecosystem and act accordingly", cooperating with other teams within the organization.
- Solution focused – "from just producing software to instead providing consumable solutions that provide real business value to your stakeholders within the appropriate economic, cultural, and technical constraints. Software is clearly important, but in addressing the needs of our stakeholders we will often provide new or upgraded hardware, change the business/operational processes that stakeholders follow, and even help change the organizational structure in which our stakeholders work."
- Delivery focused – orientation to continuous delivery, throughout the lifecycle,
- Goal driven – Team should adapt to change of requirements and development priorities. "DAD's goal-driven approach underlies the idea that to be effective at applying agile a team must understand the context in which they are working… different teams face different situations; therefore they will need to adopt their strategy to reflect the situation. Each team needs to identify an initial technical strategy, explore their initial scope, develop an initial plan, and fulfill many other goals but they will achieve these goals in different ways. The DAD process framework provides straightforward guidance to help you to make these tailoring decisions effectively. It does this by explicitly describing the process decision that you are making and then walks you through the process of making it."

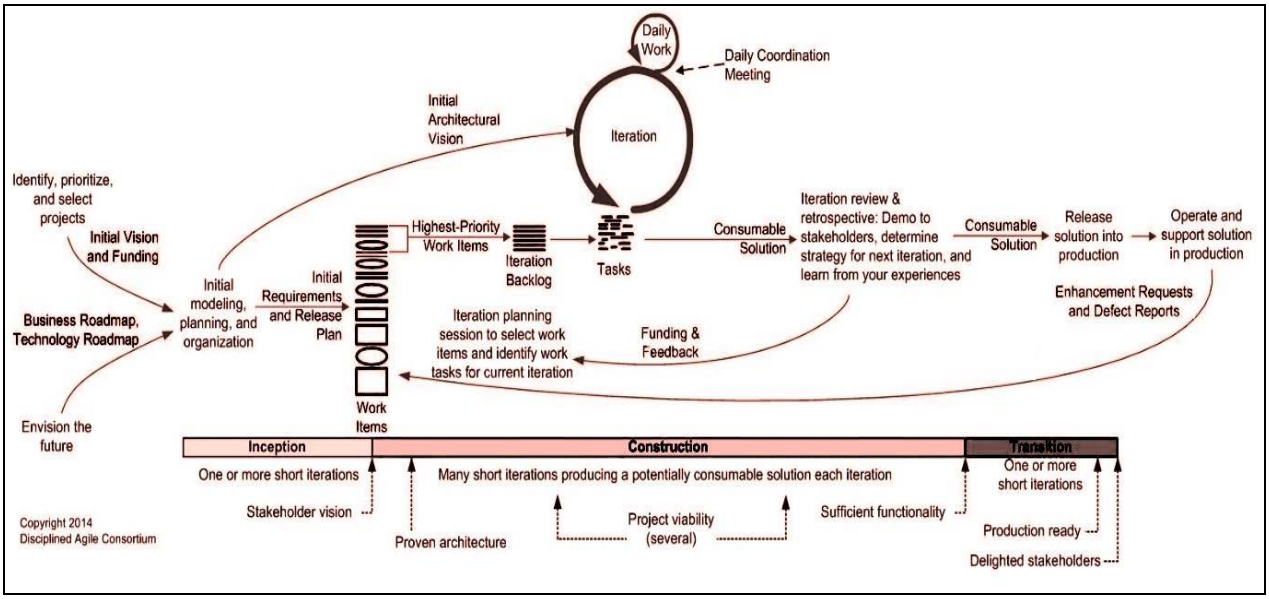

Figure 1. Disciplined Agile Delivery Life Cycle ([17] [28])

DAD life cycle is presented (in [17], Figure 1,) within steps and iterations as follows:

1. DAD lifecycle starts with identification, prioritization and selection of projects, where initial vision and funding of each project is defined.
2. Inception phase of a project goes through one or more short iterations. It consists of initial modeling, planning and organization where initial requirements and release plan is delivered and finally, stakeholder consensus is established.
3. Construction phase is done with short iterations and each iteration produces potentially consumable solution. Work items are defined and highest priority work items are selected to be included in iteration backlog. Tasks are defined upon iteration backlog. Tasks are done within iteration during each day work where each day has daily coordination meeting. After iteration is finalized, potentially consumable solution is delivered for iteration review and retrospective, demo to stakeholders is created and presented and strategy for the next iteration is determined. Iteration planning session selects work items and identifies work tasks for next iteration. Construction phase is finished when sufficient functionality is developed.
4. Transition phase starts when sufficient functionality is included in solution and solution is released in production. This phase consists of several short iterations.
5. Finally, solution is operating in working environment ("working solution in production") with support available for enhancements requests and defect reports.

III. MOTIVATION - POSITION OF DISCIPLINED AGILE DELIVERY APPROACH IN HIGHER EDUCATION

Detailed analysis of why agile software development should be included in software engineering educational programs emphasizes ten most important reasons [18]: 1. Agile was evolved and is applied in the industry; 2. Agile educates for teamwork; 3. "Agile" deals with human aspects; 4. "Agile" encourages diversity; 5. "Agile" supports learning processes; 6. Agile improves habits of mind; 7. Agile emphasizes management skills; 8. Agile enhances ethical norms; 9. Agile highlights a comprehensive image of software engineering; 10. Agile provides a single teachable framework.

In aim to align education with the needs of professional environment, agile methods are applied at higher education within undergraduate [19] and master studies [20] [21] as advanced software engineering and project management contents as well as dedicated specific courses/subjects. Recent trends in higher education of computer science introduce undergraduate capstone courses i.e. projects, which could include [22] agile methods teaching and practical work of students dealing with professional-like projects. Moreover, special tools, such as SCRUMIA [23] (a computer game) were designed in aim to enable application of agile methods and improve learning experiences. Analysis of particular courses and educational experiences of using agile methods show that different agile methods are presented theoretically, but one of the methods (such as SCRUM) is mostly practically exercised with students' teams dealing with software projects. DAD framework represents a novel approach [5] which is still not included within educational environments. Therefore, it is very important to examine elements of this approach, particularly the role of modeling, which could influence change in higher education in information systems and software engineering.

IV. CASE STUDY RESEARCH METHODOLOGY

In this paper we present empirical research in a case study that is conducted at University of Novi Sad, Technical Faculty "Mihajlo Pupin" Zrenjanin, Serbia. Basic elements of research methodology are represented as starting statements regarding previously formulated research questions and as research questions that this case study address, including methods that are used.

A. Starting statements regarding research questions

Question 1: Is there a need for modeling within disciplined agile delivery in information system development? *Statement*: There is a need for modeling in any information system development, and DAD methodology denotes that need as "initial modeling" [17]. Question 2: Which models to use in aim to minimize efforts in information systems software development? *Statement*: Basic information system development models include business process models, functional models and data models [24][25]. They are needed for any information system development.

B. Research questions in the case study

1. Since DAD methodology denote "initial modeling", which level of details is appropriate?

2. Which models are necessary (core)? Which models to use in aim to minimize efforts in creation of models?

3. By selecting particular types of models, is the selection appropriate? b) Which criteria could prove that the selection of models is appropriate?

C. Modeling process selection

Regarding previously selected research questions in this case study, particular information system software development process is selected for this case study: Requirements collection starts with collection of documentation representing the business process of an organization, functional requirements specification from clients and analysis of documentation forms. Method of structural system analysis is used for presenting business process model and data flow by using data flow diagram and data dictionary. Process tree represents a basis for mapping of primitive processes to software functions, while data dictionary elements are used as a basis for conceptual data model creation. Mapping of elements from business process models to software design is presented in [11]. After creating business process model, i.e. data flow diagram with data dictionary, UML's use case diagram is created for the functional modeling purpose, while conceptual data model, physical model and object oriented model (class diagram) is created for the data modeling purpose. All models (i.e. diagrams with additional specifications - business process model, use case model and data models) are created in CASE tool Power Designer, by using advantage of data interoperability between models (export data from business process model to conceptual data model) and advantage of automated creation of models (from conceptual data model to physical data model and object oriented model).

Obviously, business process model is core model which gives basis for functional modeling (use case model) and data modeling (conceptual and physical model, as well as object oriented model – class diagram). Main question is "*In aim to minimize time and efforts in modeling, could business process modeling be avoided? Could we just do minimal modeling in functional and data segment without previous business process modeling? What are the consequences if we omit business process modeling?"*

D. Indicators and hypothesis selection

Within the project management "iron triangle" approach, basic success factors for any project is related to scope, quality, time and resources/cost. [26] Since cost is closely related to time, and quality is closely related to scope, we select scope and time as basic quality indicators for this case study.

Research hypotheses could be formulated as:

Hypothesis 1 related to time indicator – "Business process modeling increase overall project duration".

Hypothesis 2 related to time indicator - "Omitting business process modeling increase number of development iterations in software development".

Hypothesis 3 related to scope indicator – "Business process modeling enables completeness of the project scope".

Hypothesis 4 related to scope indicator – "Omitting business process modeling gives partial results of the project scope".

E. Case Study Research Sample and Methods

In this paper, sample represent results of students' projects implemented within educational environment. There are two categories of students' projects:

1. First category are mandatory projects within practical exams at University of Novi Sad, Technical faculty "Mihajlo Pupin" in Zrenjanin. In aim to fulfill prerequisites for entering exam, students need to do their practical homework. First category of projects included business process modeling.

2. Second category projects are with optional engagement in development of information system of an educational institution. During March – July 2014. students were organized to implement projects of information system development at University of Novi Sad, Technical faculty "Mihajlo Pupin" in Zrenjanin [27]. Overall organization was set according to DAD methodology. Their projects' mentor had a role of stakeholders' representative for each of these projects. Second category of projects did not include business process modeling, but only use case model as well as conceptual and physical data models.

Methods for testing previously represented hypotheses upon the empirical results are related to simple comparison (first type of projects compared to second type of projects) of number/percentage of each indicator's average occurrences, presented graphically. Data in average number/percentage is based on estimation for the category of projects made by mentor of these projects.

In aim to enable comparison, selection of projects for sample is made in aim to have both groups comparable. Both groups of projects show many similarities:

- Both groups of projects have the same number of students (25) working on the same number of projects (20); both groups of students have the same characteristics in both groups: gender (5

female students and 20 male students), study level (10 master-level students and 15 bachelor-level students).

- Mentorship from the same teaching personnel member (i.e. teaching assistant Ljubica Kazi)
- Both groups of software is developed within information systems context, i.e. related to development of software for organizational information systems
- Both groups of projects have equal project average complexity (number of tables from database per project – namely it is 10 database tables per project)

V. CASE STUDY RESULTS AND DISCUSSION

A. Results

Hypothesis 1 related to time indicator – "Business process modeling increase overall project duration".

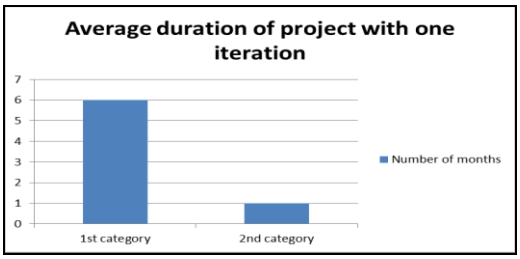

Figure 1. Average duration of project with one iteration comparison

Projects from 1st category average duration is six months including modeling and implementation up to 1st iteration completion, while projects from 2nd category average duration is 1 month.

Hypothesis 2 related to time indicator - "Omitting business process modeling increase number of development iterations in software development".

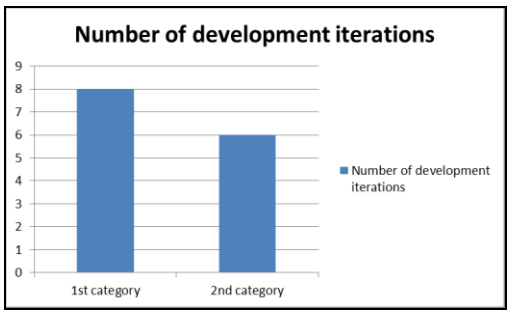

Figure 2. Number of development iterations comparison

Projects from 1st category had average of 8 development iterations, while projects from 2nd category had average of 6 development iterations. In first category, iterations are: business process modeling (1st and 2nd), use case model (1st and 2nd), conceptual data model (1st and 2nd) and software development in first iteration complexity level (1st and 2nd). This average statistics shows that this hypothesis is not valid – statistics proves that 2nd category of projects without business process modeling had less development iterations.

Hypothesis 3 related to scope indicator – "Business process modeling enables completeness of the project scope".

Hypothesis 4 related to scope indicator – "Omitting business process modeling gives partial results of the project scope".

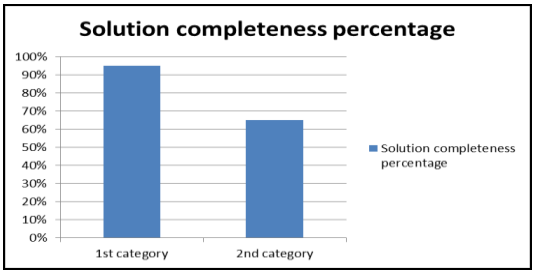

Figure 3. Solution completeness percentage comparison

Percentage of solution completeness is related to the percent of software functions designed compared to the total number of software functions implemented in solution. For the 1st category, percentage of solution completeness designed and implemented is 95%, while in the 2nd category is 65%.

B. Discussion

Case study in this paper is based on estimation of duration of project, number of iterations and percentage of completeness of developed solutions compared to designed features. This estimation is made by projects mentor. Case study is based on comparison of projects from 1st category (mandatory projects of information system development that include business process modeling) and 2nd category (optional projects of information system development that do not include business process modeling).

Regarding first hypothesis, projects from 1st category show much longer duration comparing to projects that do not include business process modeling. Second hypothesis observations show that projects with business process modeling had more development iterations comparing to those that did not have business process modeling included in project activities. Finally, projects that had business process modeling included had more complete final solutions after first iteration, comparing to those having absence of business process modeling.

Finally, it is needed to give answers to previously presented questions:

1st question: *In aim to minimize time and efforts in modeling, could business process modeling be avoided? Could we just do minimal modeling in functional and data segment without previous business process modeling?*

Possible answer: Software solutions within information system development could be developed with minimum modeling including functional aspect (use case) and data aspect (conceptual data model) and business process modeling could be avoided. If time is important, project duration and number of development iterations would be less.

2nd question: What are the consequences if we omit business process modeling?

Possible answer: Omitting business process modeling could lead to incomplete solutions, not having concerned all business process needs and appropriate software mapping. If scope is important, business process modeling brings more complete solution basis.

VI. CONCLUSIONS

This paper aim is to investigate the role of modeling in disciplined agile delivery approach within information system development. DAD methodology denotes "initial modeling", but which level of details is appropriate? In this paper we presented a case study which focused on the role of business process modeling and the need for these models inclusion in DAD approach to information system development. Finally, models needed for DAD approach applied in information systems development should include functional model (such as UML's use case diagram) and data model (conceptual model) as two core types of models. Business process model could be avoided, since it makes project duration longer and increase number of development iterations. Still, business process model inclusion improves project scope, i.e. solution completeness.

This paper conclusions are related to emphasizing the need for functional and data modeling, while business process modeling inclusion in DAD is analyzed from the time and scope perspective. If time perspective is considered more important, business process modeling should be avoided, but if scope perspective is emphasized, business process modeling improve the solution completeness. Finally, there is no unique answer. Business process modeling is a basis for both functional and data modeling, but experienced professionals could include this activity as abstract mapping between business processes to elements of functional and data models, needed for implementation.

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