

Presented to the Interdisciplinary Studies Program:



UNIVERSITY OF OREGON
APPLIED INFORMATION MANAGEMENT

Applied Information Management
and the Graduate School of the
University of Oregon
in partial fulfillment of the
requirement for the degree of
Master of Science

Benefits of Blending Agile and Waterfall Project Planning Methodologies

CAPSTONE REPORT

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December 2015

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Abstract

With continuous changes in technology and the project management practices used to deliver successful software projects to the business and users, Information Technology leaders need to optimize and adapt to find more effective management approaches. Understanding the strengths and weaknesses of both the waterfall and agile methodologies in order to choose and blend the characteristics that align best to meet the needs for a project is key to delivering a successful project.

Keywords: blending of traditional and agile project management *abstract*, hybrid project planning agile, B2B e-commerce stakeholders, successful project plan, mixed agile waterfall project management, using a blended project planning process, blend agile, agile manifesto, *B2B* agile project management, *waterfall* planning method, waterfall methodology origin, waterfall methodology *originate*, and hybrid project management.

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Introduction

Problem

A traditional software development methodology, typically referred to as waterfall, is a linear approach to development that has distinct project life cycle phases that are completed in sequence, assumes events affecting the project are predictable, all tools and activities are understood, and stresses the importance of upfront requirements gathering (Hass, 2007). Plan-driven processes, such as those included in the traditional waterfall methodology, originate from aerospace and other manufacturing industries, where robustness and correctness are usually important concerns, but these methodologies are often considered too rigorous, inflexible, and a bit old-fashioned for many software development projects (Paulus, Mohammadi, & Weyer, 2013). The waterfall methodology does have recognized useful characteristics, such as the requirement for formal documentation. Waterfall tends to work best for bigger projects, when team members are distributed and fluctuate frequently, and when system criticality is high (Špundak, 2014). Despite the popularity of other development methodologies such as agile development, some software engineers dismiss agile methodologies and strongly advocate the value of using traditional methodologies (Jiang & Eberlein, 2008).

A competing school of thought is that the traditional waterfall methodology is ineffective; the agile methodology arose in response to these perceived weaknesses and was designed to be a highly iterative and incremental process, where developers and project stakeholders actively work together to understand the domain, identify what needs to be built, and prioritize functionality (Hass, 2007). In 2001, prominent software developers from both IT and software engineering domains convened to arrive at a consensus on how the software development

industry could produce better results. This meeting produced the Agile Manifesto (Hass, 2007). Useful characteristics of the agile method are planning when requirements are unclear; allowing the development team to be creative; innovative, close and frequent collaboration with users and business partners; and managing an iterative project plan that is complex (Špundak, 2014).

For some business sectors, software development projects pose more challenges than in other sectors. For example, in the e-services sector, companies with a large customer base do not need just the rapid value that is provided with agile methodologies or the high assurance that is provided by traditional waterfall methodologies – they need both (Boehm, 2002). Boehm's (2002) recommendation applies to the e-services sector but is also applicable to Business-to-Business (B2B) electronic commerce (e-commerce). Fraunholz, Chan, and Swatman (2003) describe B2B e-commerce as:

An integrated information system used by two or more participant organizations which agree to exchange their business information and processes electronically. In the earliest days of inter-organizational systems (IOS), relationships tended to exist primarily between long-term partners (usually suppliers and customers), although the rise of Internet based e-commerce has led to the development of a wider variety of e-commerce relationships, of which the two major types are business-to-business (B2B) and business-to-consumer (B2C). (p. 2)

Success in implementing B2B e-commerce projects depends on how the organization handles the implementation; organizational attitudes and the business context are just as important as rapidly changing technology in terms of the directions taken during the implementation process (Fraunholz, Chan, & Swatman, 2003). The need for both rapid value and

high assurance in project development for B2B e-commerce is due to the customer base; changes need to be quick with little impact to the users and without interruption to the service being provided. A single approach that provides either pure agility or the pure plan-driven discipline of waterfall cannot meet these needs; a mix of each approach is needed (Boehm, 2002).

Agile project management (APM) can benefit from traditional project management's (TPM) clear guidance on project initiation and closure, communications management, project integration management, project cost management, as well as risk management. TPM can benefit from APM's autonomous teams, flexibility, and acceptance of the need to continuously adjust; APM keeps clients involved and reduces documentation (Lozo & Jovanović, 2012). Both traditional and agile methodologies have advantages and disadvantages, so it is not possible to uniformly assert that one methodology is better than another (Špundak, 2014). Finding the optimal mix of appropriate methodology elements that will contribute to the project success can be challenging (Špundak, 2014).

Purpose

The focus of this paper is to present literature that describes the history and characteristics of the traditional and agile project management methodologies. Sources are selected that identify limitations, strengths, and weaknesses of each methodology in order to promote a better understanding of their best practices and uses for managing large-scale projects. Sources also define the project management approach of blending the agile and traditional project management methodologies best practices, descriptions of how a blend can increase the chances of delivering a successful project, and the roles and responsibilities of stakeholders engaged in projects using blended methodologies.

Research Questions

Main question. What are the best practices from agile project management and traditional project management that can be used together in a blended methodology to successfully plan, manage, and deliver large-scale projects?

Sub-questions. How do the identified best practices of APM and TPM map to specific project needs (i.e., the need for upfront planning, risk analysis, rapid delivery, or the need for flexibility in requirements)? What are the roles and responsibilities of key project stakeholders in TPM, APM, and blended methodologies?

Audience

Following the demands of IT project management, leaders in the industry are optimizing and adopting different and new, more effective styles and strategies (Lozo & Jovanović, 2012). For a vast majority of projects, the pure APM or the pure TPM is not effective, and the flexible hybrid project management approach, which combines elements of APM and TPM, is the most appropriate solution (Lozo & Jovanović, 2012). Chief Information Officers (CIOs), IT directors, and IT managers have vested interests in ensuring that projects are delivered successfully. In addition, the project managers who are charged with successfully delivering large-scale projects will benefit from the literature that informs waterfall project management, agile project management, and project management approaches that rely on blending these methodologies.

This paper presents literature to inform an improved project management approach, blending aspects of both traditional and agile methodologies for project teams. Serrador and Pinto (2015) define successful project delivery as (a) project efficiency – meeting cost, time and

scope goals; and (b) stakeholder success – satisfying the expectations of the project stakeholders who are the best judges of the overall success. For the purposes of this annotated bibliography, these project stakeholders are represented across the organization, motivated, and prepared to participate in the project (Aggestam & Söderström, 2006).

Search Report

Search strategy. Information regarding the problem and audience for a blended planning methodology is collected through various sources and methods. Peer-reviewed papers are located using the search engines of the University of Oregon Library quick search, Academic Premier Search, Google Scholar, Google, and Directory of Open Access Journals (DOAJ). Additional sources are located by reviewing the bibliographies of selected sources for relevant citations and selecting those relevant sources from the author's personal library; the resulting reference sources are listed in the annotated bibliography.

Data collection. Initial searches of the literature are conducted on the subject of planning methodologies, traditional, waterfall, and agile, and a mixture or blend of the practices. Published articles collected using the University of Oregon library online databases, Google Scholar, and Google meeting the following criteria are given priority:

- Published in a peer-reviewed journal, preferably academic;
- Cited in other peer-reviewed journals;
- Published between 2001 - 2015;

Keywords. The following keywords and phrases are used in the search for reference sources:

- Blending of traditional and agile project management *abstract*,

- hybrid project planning agile,
- B2B e-commerce stakeholders,
- successful project plan,
- mixed agile waterfall project management,
- using a blended project planning process,
- blend agile,
- agile manifesto,
- *B2B* agile project management,
- *waterfall* planning method,
- waterfall methodology origin,
- waterfall methodology *originate*, and
- hybrid project management.

Search engines and databases. Searches are performed in the UO Library, Google Scholar, Google, and DOAJ. The resulting selected articles are housed on the following databases:

- Research Gate
- EBSCOhost
- ACM Digital Library
- CIS Journal
- Springer
- Elsevier
- PM World Today
- IEE Computer Society

- Science Direct
- Software Development
- Journal of Emerging Trends in Computing and Information Sciences
- I.J. Information Technology and Computer Science
- Visible Thread
- Association for Computing Machinery

Reference evaluation criteria. Using the five key evaluation criteria provided by the Center for Public Issues Education (2015) of authority, timeliness, quality, relevancy, and bias, each article included in the annotated bibliography is reviewed and analyzed with the following process:

- Authority – Focus is placed on peer-reviewed journals and sources where the author has professional credentials and is recently associated with a reputable organization. Priority is also given to literature where others have referenced the source in the field.
- Timeliness – The publication dates are limited to 2001 – 2015 due to the introduction of the agile planning methodology in 2001. Most references are targeted to more current publication dates in order to review the most prevailing perspectives and findings.
- Quality – References include accurate grammar and spelling, and are structured in a logical and informative flow.
- Relevancy – Chosen references include discussions of agile or waterfall/traditional planning methodologies, and creating a blend or combination

of methodologies. Focus is placed on scholarly sources rather than popular sources where possible.

- Bias – Sources are reviewed for the inclusion of multiple perspectives of the topic and the conclusion is supported by evidence from the different perspectives. The author's arguments and conclusions are supported by credible and cited sources. Sources are avoided where the author is selling a related product or service.

Documentation approach. After locating a possible reference, the key information and search criteria are noted in an Excel document, including the search engine, key words or phrases used, database, the link to the actual reference, the bibliographic citation, and the abstract. A PDF is saved to a local file and printed. In the printed reference, key phrases are identified and classified in terms of their relation to the subject categories of this paper; waterfall project management, agile project management, and project management approaches that blend these two methodologies. A subject category is selected for each source depending for which category it will be most useful.

Annotated Bibliography

This annotated bibliography introduces 16 references that provide insight into the waterfall and agile project management methods, and options for blending those methods to leverage strengths from each approach. The selected references are intended to provide CIOs, IT directors, IT managers, and project managers with visibility to the best practices of project management methods and blending options to increase the chances of delivering successful projects. References are presented in three categories: (a) waterfall project management, (b) agile project management, and (c) blending project management methodologies.

Annotations are supported by three sources of information: (a) full bibliographic citations, (b) literature abstract, and (c) summary of the literature. The abstracts are presented as published. A description of the work is provided for literature without abstracts. Summaries are a review of the literature with a focus on the elements that support the purpose of this paper. The intended outcome of this annotated bibliography is to provide those who are charged with successfully delivering projects with alternatives for managing projects.

Resources focused on waterfall project management methodologies

Bassil, Y. (2012). A simulation model for the waterfall software development life cycle.

International Journal of Engineering & Technology (iJET), 2(5), 742-749. ISSN: 2049-3444

Abstract. Software development life cycle or SDLC for short is a methodology for designing, building, and maintaining information and industrial systems. So far, there exist many SDLC models, one of which is the Waterfall model, which comprises five phases to be completed sequentially in order to develop a software solution. However,

SDLC of software systems has always encountered problems and limitations that resulted in significant budget overruns, late or suspended deliveries, and dissatisfied clients. The major reason for these deficiencies is that project directors are not wisely assigning the required number of workers and resources on the various activities of the SDLC.

Consequently, some SDLC phases with insufficient resources may be delayed; while, others with excess resources may be idled, leading to a bottleneck between the arrival and delivery of projects and to a failure in delivering an operational product on time and within budget. This paper proposes a simulation model for the Waterfall development process using the Symphony.NET simulation tool whose role is to assist project managers in determining how to achieve the maximum productivity with the minimum number of expenses, workers, and hours. It helps maximizing the utilization of development processes by keeping all employees and resources busy all the time to keep pace with the arrival of projects and to decrease waste and idle time. As future work, other SDLC models such as spiral and incremental are to be simulated, giving project executives the choice to use a diversity of software development methodologies.

Summary. This paper proposes a simulation model mimicking the waterfall software development lifecycle methodology from the analysis phase to the maintenance phase. The simulation outlines the needs of different stakeholders throughout the development process and reviews, in detail, each phase of the waterfall method: analysis, design, implementation, testing, and maintenance. In the analysis phase, requirements are defined with a complete and comprehensive description of the software to be developed. Both functional and non-functional requirements are defined and include a purpose, scope, perspective, functions, software attributes, user characteristics, functionality

specifications, interface requirements, and database requirements. The design phase defines the plan for the solutions, which includes algorithm design, software architecture design, database conceptual schema, logical diagram design, concept design, graphical user interface design, and data structure definition. The implementation phase is when the real code is written and compiled into an operational application. The testing phase contains the processes to check to make sure the software solution meets the original requirements and specifications and that the software accomplishes its intended purpose. Finally, the maintenance phase is the process of modifying the software solution after delivery and deployment to refine the output, correct errors, and improve performance and quality. The aim of the paper and the research of the simulation model is to assist project managers in determining the optimal number of resources required to allocate for individual activities for each of the phases of a particular project for an allotted schedule and budget. This article is useful for this specific research study because it provides detailed descriptions of the phases of the waterfall methodology, an analysis of the needs of key stakeholders in each phase, and insight into approaches a project manager can utilize to plan the number of resources needed for a project.

Paulus, S., Mohammadi, N. G., & Weyer, T. (2013). Trustworthy software development. In B. D. Decker, J. Decker, C. Kraetzer, & C. Vielhauer (Eds.), *CMS 2013* (233-247). ebook: Springer. <http://dx.doi.org/10.1007/978-3-642-40779-6>

Abstract. This paper presents an overview on how existing development methodologies and practices support the creation of trustworthy software. Trustworthy software is key for a successful and trusted usage of software, specifically in the Cloud. To better understand what trustworthy software applications actually mean, the concepts of

trustworthiness and trust are defined and put in contrast to each other. Furthermore, we identify attributes of software applications that support trustworthiness. Based on this groundwork, some well-known software development methodologies and best practices are analyzed with respect to how they support the systematic engineering of trustworthy software. Finally, the state of the art is discussed in a qualitative way, and an outlook on necessary research efforts and technological innovations is given.

Summary. This paper defines the difference between trust and trustworthiness with regard to existing development methodologies. Stakeholders, based on their perception of whether their requirements are met or exceeded, determine trust. Stakeholders also determine if a system is trustworthy with respect to the confidentiality of sensitive information, the integrity of valuable information, the availability of critical data, and the response time or accuracy of production. The paper reviews the elements of nine different development methodologies that increase or inhibit trust and how the approaches could be used for modeling trustworthiness; specifically in the plan-driven, or waterfall, and incremental, or agile methodologies.

In the plan-driven model the only trustworthiness gain comes when a system is more suited to have stringent safety, reliability, or security requirements. The trustworthiness losses for a plan-driven model occur when the possibility of vague or missing security requirements occur, the model does not offer cost-benefits over other approaches, limited flexibility is possible for changes needed late in the development process, and there is a lack of usability modeling.

In the incremental model the trustworthiness gains come with the ability to incorporate new and evolving requirements as part of the iterative process and by

providing the customers with a positive sense of ownership and understanding of the product due to their participation in the development process. The trustworthiness losses for the iterative model include a mismatch between organizational policies and the agile process; the lack of non-functional requirements documentation resulting in security flaws; and difficulties testing and evaluating security, causing a loss of focus on development. Stakeholders' feelings of trust and determination of the trustworthiness of a system have major impacts on the acceptance of a new system, which must be taken into account, analyzed, and documented as thoroughly as possible to provide transparency of the decisions that were made during development.

This article is useful for this specific research study because it describes where the waterfall model originated and the importance of the business stakeholders in determining a system's trustworthiness in both the plan-driven and incremental project models. The specific information on what causes gains and losses of trustworthiness for waterfall and agile methodologies provides actionable lessons to identify best practices from both development approaches.

Petersen, K., Wohlin, C., & Baca, D. (2009). The waterfall model in large-scale development. *Product-Focused Software Process Improvement*, 32, 386-400.

http://dx.doi.org/10.1007/978-3-642-02152-7_29

Abstract. Waterfall development is still a widely used way of working in software development companies. Many problems have been reported related to the model. Commonly accepted problems are for example to cope with change and that defects all too often are detected too late in the software development process. However, many of the problems mentioned in literature are based on beliefs and experiences, and not on

empirical evidence. To address this research gap, we compare the problems in literature with the results of a case study at Ericsson AB in Sweden, investigating issues in the waterfall model. The case study aims at validating or contradicting the beliefs of what the problems are in waterfall development through empirical research.

Summary. This paper presents a case study investigating issues related to the waterfall development methodology applied to a large-scale development process and compares those findings to various literature sources that discuss the same issues. In the case study the biggest issue found is related to the requirements gathering and verification process utilized in the waterfall method, which the authors found to be mostly due to the fact that requirements change throughout the development process and it is difficult to incorporate these changes into the waterfall process. The authors also found reports of similar issues with waterfall development in other literature sources and provided more detailed explanations of the issues, namely (a) confusion about who implements different versions of the requirements, (b) high effort for maintenance of the resulting software, (c) specialized focus on employees' competence and capabilities may bring the impression of the lack of confidence in these employees, and (d) problems in system localization due to different subsystems causing communication barriers when there are issues. The authors conclude that the waterfall development methodology is therefore probably not suitable for a large-scale development process. This article is useful for this specific research study because it identifies and describes in detail the issues found when using the waterfall planning methodology for a large-scale development project.

Sommer, A. F., Dukovska-Popovska, I., & Steger-Jensen, K. (2013). Barriers towards integrated product development — Challenges from a holistic project management perspective.

International Journal of Project Management, 32, 970–982.

<http://dx.doi.org/10.1016/j.ijproman.2013.10.013>

Abstract. The basis for product development in many large industrial companies is a traditional project management method positing non-overlapping phases, independent activities, and a dedicated project team. Research findings indicate that the use of integrated product development methods increases performance compared to traditional methods in contexts of complex problem solving, which are disruptive and non-linear. Even though integrated product development has been the focus of a large number of research studies, these studies mostly focus on identifying success criteria and improving performance, while the requirements for implementing integrated product development remain under-researched. This study takes a more holistic project management perspective and identifies both the challenges and the requirements of successful implementation through an in- depth case study. It was found in a chosen case company that successful implementation requires awareness and skills of integrated product development in senior management, as well as a set of cross-organizational project governance structures.

Summary. This paper investigates the challenges and requirements of successful product development implementations using the traditional, or waterfall planning methodology. The authors review literature devoted to elements of product development project management and describe the qualitative data gathering method used in the case study, in which the authors observed a company for a year. The data was collected via individual and group interviews of project managers, project employees, and steering committee managers. The findings of the various interviews are presented, analyzed, and discussed

to provide recommendations for managing product development projects. The authors' findings include issues caused by a lack of product development governance, specifically challenges in applying a generic linear process model, like those used in the waterfall methodology. Other findings include the need for cross-organizational resource management to increase alignment between projects and the business strategy. Specifically, a generic project model does not provide guidelines and tools for practical project management; the project model is not followed in cross-organizational projects; and customer delivery dates remain constant, but internal deadlines are either pushed or not used. Combined, these three challenges put a strain on projects and project employees in the business unit. This article is useful for this specific research study because it provides details of challenges of the waterfall planning methodology experienced by a real corporation in a product development project, specific challenges gleaned from feedback from its employees through interviews, and recommendations for managing product development projects.

Resources focused on agile project management

Boehm, B. (2002). Get ready for agile methods, with care. *Computer*, 35(1), 64-69.

<http://dx.doi.org/10.1109/2.976920>

Description. Although many advocates consider the agile and plan-driven software development methods polar opposites, synthesizing the two can provide developers with a comprehensive spectrum of tools and options.

Summary. This article introduces agile methodology characteristics and the benefits they provide to organizations currently utilizing a plan-driven or waterfall approach. The planning approaches for both the waterfall and agile methods are described, with focus on

the details of the agile methodology. The author compares how each methodology utilizes developers, customers, requirements, architecture, and team size. The article also presents how to balance agility and incorporate risk management when utilizing the agile methodology. The authors note that key strengths of the waterfall methodology include an investment in life-cycle architectures and plans to reduce project risk and a plan-driven method works better for large-scale projects. The authors identify the weaknesses of the waterfall methodology as it not being adaptable to requirement changes and taking longer to produce results. In contrast, the authors identify key strengths of the agile development methodology supporting customers to operate in dedicated mode with the development team, ideal for smaller team sizes, and incremental and frequent delivery of functionality. Finally, the authors identify weaknesses of the agile methodology as unrecognized shortfalls in early planning causing irrecoverable architectural issues, misapplied requirement changes can cause disastrous results, and increase in refactoring effort with inadequate developers.

This article is useful for this specific research study because it provides detailed characteristics of the agile and waterfall project planning approaches and identifies specific strengths and weaknesses of both methodologies. It also outlines the characteristics of each method's key project areas: (a) developers, (b) customers, (c) requirements, (d) architecture, (e) refactoring, (f) size, and (g) primary objective.

Fowler, M. & Highsmith, J. (2001). The agile manifesto. *Software Development*.

<http://www.pmp-projects.org/Agile-Manifesto.pdf>

Abstract. In the past 12–18 months, a wide range of publications—Software Development, IEEE Software, Cutter IT Journal, Software Testing and Quality

Engineering, and even *The Economist*—has published articles on what Martin Fowler calls the New Methodology, reflecting a growing interest in these new approaches to software development (Extreme Programming, Crystal Methodologies, SCRUM, Adaptive Software Development, Feature-Driven Development and Dynamic Systems Development Methodology among them). In addition to these "named" methodologies, scores of organizations have developed their own "lighter" approach to building software.

Summary. Seventeen software development professionals created the agile manifesto in February 2001. This paper outlines the agile movement and strives to restore credibility and balance to the agile methodology by explaining that it is not an anti-methodology movement but rather a methodology that promotes collaboration and continuous delivery. It presents the key values of the agile method (a) individuals and interactions over processes and tools, (b) working software over comprehensive documentation, (c) customer collaboration over contract negotiation, and (d) responding to change over following a plan. These values are developed due to the turbulent world of business and technology; scrupulously following a plan can have dire consequences for a project, even if the plan is executed faithfully. Agile provides early, continuous, and frequent delivery of the product because it is more flexible when requirements change, allowing the business and technical team to work closely together and focus on the final product: delivering working software. The principles of the agile methodology presented in this article are useful for this specific research study because they highlight the benefits of the agile methodology that enable software development projects to progress quickly and collaboratively.

Serrador, P. & Pinto, J. K. (2015). Does Agile work? — A quantitative analysis of agile project success. *Science Direct*, 33, 1040–1051.

<http://dx.doi.org/10.1016/j.ijproman.2015.01.006>

Abstract. The Agile project management methodology has been widely used in recent years as a means to counter the dangers of traditional, front-end planning methods that often lead to downstream development pathologies. Although numerous authors have pointed to the advantages of Agile, with its emphasis on individuals and interactions over processes, customer collaboration over contracts and formal negotiations, and responsiveness over rigid planning, there are, to date, very few large-scale, empirical studies to support the contention that Agile methods can improve the likelihood of project success. Developed originally for software development, it is still predominantly an IT phenomenon. But due to its success it has now spread to non-IT projects. Using a data sample of 1002 projects across multiple industries and countries, we tested the effect of Agile use in organizations on two dimensions of project success: efficiency and overall stakeholder satisfaction against organizational goals. We further examined the moderating effects of variables such as perceived quality of the vision/goals of the project, project complexity, and project team experience. Our findings suggest that Agile methods do have a positive impact on both dimensions of project success. Further, the quality of the vision/goals is a marginally significant moderator of this effect. Implications of these findings and directions for future research are discussed.

Summary. This paper investigates the agile methodology in comparison to traditional approaches for achieving project success. It presents a study that was structured to test the effectiveness of the agile philosophy on different dimensions of project success,

across multiple industries, in order to identify the degree to which agile can be directly linked to project success. The elements of project success that are analyzed are project efficiency (meeting the cost, scope, and scope goals) and overall stakeholder success (satisfying the expectations of project stakeholders who are the best judges of overall success).

A literature review of agile methods and project success is presented, along with the research methods used for the investigation. The results presented from the study establish that the agile methodology has been widely adopted by the participants in the investigation and that the level of agile used in a project does have a statistically significant impact on the success of the project; the authors found that the higher the level of agile used in a project, the higher the probability of project success. These results are useful for this specific research study because they present the benefits of the agile methodology that align with the dimensions of project success presented.

Williams, L. & Cockburn, A. (2003). Guest editors' introduction: Agile software development: it's about feedback and change. *IEEE Computer Society*, 36(6), 39-43.

<http://dx.doi.org/10.1109/MC.2003.1204373>

Description. Agile software development has hit a nerve in the software development community. Some people argue vociferously for it, others argue equally against it, and others are working to mix agile and plan-driven approaches. Many more people wonder just what agility is. This paper describes what the agile methodology is, the values as written in the “Manifesto for Agile Software Development”, and introduce articles that capture the state of the current conversation of the agile method.

Summary. This article presents the agile methodology and its value to the field of project management. The authors discuss how the agile methodology aligns better with the fact that software development is empirical (non-linear) versus a methodology that follows a defined process. The authors present conversations about how the approach to software development has changed as technology has changed. The subject of the conversation is how agile methods are not necessarily new, but that the blending of the agile techniques into a theoretical and practical framework is new. Another conversation the authors provide discusses the scalability of agile; the authors note that the values and practices of agile are best suited to co-located teams of about 50 people or fewer, projects with easy access to user and business experts, and development projects that are not life-critical. This article is useful for this specific research study because it defines the agile project methodology, provides a historical context for the growth of the agile methodology in response to changes in technology, defines the values and practices of agile methodologies, and defines best practices for agile that align with these values.

Resources focused on blending project management methodologies

Baird, A. & Riggins, F. J. (2012). Planning and sprinting: Use a hybrid project management methodology within a CIS capstone course. *Journal of Information Systems Education*, 23(3), 243-257. ISSN: 10553096

Abstract. An increasing number of information systems projects in industry are managed using hybrid project management methodologies, but this shift in project management methods is not fully represented in our CIS curriculums. CIS capstone courses often include an applied project that is managed with traditional project management methods (plan first, execute second). While agile methods (adapt to change through iterations) are

making inroads, little research has been conducted on using a hybrid of these two project management methods in a capstone course. In this paper, we explain the hybrid project management methods we used in four sections of an undergraduate CIS Capstone course during the Fall and Spring of the 2011-2012 academic year. We also present the results of an end-of-term student satisfaction and critical success factor survey. We find that overall satisfaction with the hybrid approach is high among our sample. We also find that more client involvement and a pragmatic approach to initial project planning are areas for future improvement. The results of our experience and survey provide lessons learned and best practices for those who wish to provide students with applied experience that combines waterfall (traditional) and Scrum (agile) project management techniques in their own courses.

Summary. The goal of this paper is to demonstrate the validity of using a hybrid project management process, using student-developed prototypes for a real-world client combining traditional (waterfall) and agile project management methodologies. The paper begins by providing the background of the traditional project management (TPM) and the agile project management (APM) methods. The background descriptions outline the approach, characteristics, benefits, and risks of each methodology. It also introduces the benefits of a hybrid approach, which include: a focus on business value versus focusing on time and budget only, the ability to customize the project management methodology to the problem at hand rather than applying a single method, and the provision of higher software quality on complex projects. The authors found that satisfaction with the use of a hybrid methodology is high with compatibility and relative advantage having significant impacts on satisfaction associated with the use of a hybrid

methodology. The authors also found that overall customer satisfaction can be lowered if the client is perceived as having limited involvement and that efforts need to be made to ensure teams are meeting regularly and updating their sprint backlogs.

This paper is useful for this specific research study because it establishes the efficacy of the hybrid model via a real world case study. The article provides an example of a successful hybrid project divided into three, primary sprints: (a) project plan and proposal, (b) draft prototype consisting of the critical path of the proposed project, and (c) development of a final prototype. The lessons learned from the case study can be applied as best practices of the hybrid model.

Binder, J., Aillaud, L. IV, & Schilli, L. (2014). The project management cocktail model: An approach for balancing agile and ISO 21500. *Science Direct, 119*, 182-191.

<http://dx.doi.org/10.1016/j.sbspro.2014.03.022>

Abstract. Modern PM methodologies emerged in the late 1950s and were formalized in 2012 in an International Organization for Standardization (ISO) standard: ISO/FDIS 21500:2012, Guidance on Project Management. This ISO standard follows traditional waterfall approach whereby high-level project definition is used to develop a detailed plan guiding the execution of all deliverables. Agile principles (AP) emerged in the late 1950s and were formalized in the 2001 Agile Manifesto (Larman& Basili, 2003). These principles are not reflected in the ISO standard because agile and waterfall approaches were formerly considered as ‘competing bipolar choices’ (Batra et al., 2010, p.380).

Recent research contends that both approaches can be valid, dependent on project complexities and risks (Boehm & Turner, 2003), and that a combined (cocktail) approach could prove optimal (Kahkonen, 2004; Batra et al., 2010; Barlow et al., 2010). This paper

investigates combining the AP with a waterfall PM model and compares the new ISO standard to the Agile Manifesto and previous literature on hybrid PM models. We present a novel cocktail model that balances the structure of waterfall-based models with the flexibility of AP. This model has the benefit of meeting the financial, legal and procurement standards of large companies through its use of the ISO standard elements, while introducing the agility required to adapt to changing priorities and environments.

Summary. This article assesses the correlation between the International Organization for Standardization (ISO) and the Agile Principles (AP) and recommends combining the strengths of the agile methodology into each ISO process. ISO standard follows the traditional waterfall approach whereby high-level project definition is used to develop a detailed plan guiding the execution of all deliverables. The paper compares the 39 ISO processes, from the PMBOK Guide, grouped into ten subject groups (a) integration, (b) stakeholder, (c) scope, (d) resource, (e) time, (f) cost, (g) risk, (h) quality, (i) procurement, and (j) communication and five project management process groups (a) initiating, (b) planning, (c) implementing, (d) controlling, and (e) closing, to the twelve APs to develop a hybrid project management model. This paper is useful for this specific research study because it provides an example of the cocktail model where the strengths of both the agile methodology and the ISO standards are combined, thus enabling a project planning process that allows for more planning and documentation while still adapting to changes and providing frequent deliverables.

Hass, K. B. (2007). The blending of traditional and agile project management. *PM World Today*, IX(V), 1-8.

http://mx1.chelsoftusa.com/uploads/2/8/3/8/2838312/agile_well_explained.pdf

Description. This paper explores traditional and agile project management methodologies providing life cycle models of each. It explores the benefits and risks of each methodology, going into the detail of the agile components. This provides a detailed description of the elements, which provide a basis for the agile methodology that can also be used by a traditional methodology.

Summary. This article describes both the waterfall and agile project management methodology characteristics. The waterfall approach consists of tasks completed one after another in an orderly sequence, requiring a significant part of the project to be planned up front. The agile approach is a highly iterative and incremental process, where developers and project stakeholders actively work together to understand and identify what needs to be built and prioritize the functionality. The author presents key elements of the agile method, including visual control, co-located high-performance teams, test-driven development, adaptive control, collaborative development, feature-driven development, leadership and collaboration rather than command and control, and lessons learned. Hass (2007) describes how these elements can be utilized in the waterfall software development method to improve project performance. Key recommendations include incorporating the flexibility and collaboration the agile method provides with “just enough” planning performed up-front and gathering input from customers and learning from this feedback immediately. This article is useful for this specific research study because it offers specific best practices for implementing key elements of the agile methodology into the waterfall methodology. This blended methodology is used to address inherent weaknesses of the waterfall approach while leveraging key strengths from the agile approach.

Lozo, G. & Jovanović, S. (2012). A flexible hybrid method for IT project management. *CIS Journal*, 2(7), 1027-1036.

<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.477.4394&rep=rep1&type=pdf>

Abstract. Project management (PM) landscaping is continually changing in the IT industry. Working with the small teams and often with the limited budgets, while facing frequent changes in the business requirements, project managers are under continuous pressure to deliver fast turnarounds. Following the demands of the IT project management, leaders in this industry are optimizing and adopting different and new more effective styles and strategies. This paper proposes a new hybrid way of managing IT projects, flexibly combining the traditional and the Agile method. Also, it investigates what is the necessary organizational transition in an IT company, required before converting from the traditional to the proposed new hybrid method.

Summary. This paper presents a flexible hybrid project management method that is a combination of traditional and agile methods, linking components from each method in order to more effectively manage software development projects. The paper discusses the need for organizational changes when adopting a new planning method, specifically building an autonomous self-managing development team that is flexible with change while maintaining a constant relationship with the business partners and stakeholders. The paper details the characteristics of the proposed hybrid method using the traditional method to create the framework and structure of the project and a flexible combination of the agile and waterfall elements applied to testing, integration, and the acceptance of the product in order to maintain flexibility within the project structure from initiation to completion. This paper is useful for this research study because it provides an example of

a hybrid planning method that leverages the strengths of traditional and agile methods, outlining the processes, meetings, and detailed steps needed to successfully plan and manage a software development project.

McGovern, F. (2010). Blending traditional and agile project documentation.

<http://www.visiblethread.com/wp-content/uploads/Lean-Documentation-Blending-Traditional-and-Agile-Project-Docmentation.pdf>

Abstract. As the merits of agile and iterative approaches are recognized, for many IT directors, project/program managers and Business Analyst leads, the question becomes; how to adapt current process documentation to facilitate both traditional and agile approaches across a portfolio of projects, often as part of a wider program effort.

This paper will show how it is possible to apply agile documentation practices side by side with traditional documentation practices. We present practical guidance for project documentation where a blend of traditional and agile projects may exist.

This paper is applicable to larger enterprise with a variety of project styles and will have particular relevance for enterprises looking to adopt more agile approaches for certain projects.

Summary. This paper shows how it is possible to apply agile documentation practices side-by-side with traditional documentation practices. This paper is applicable to larger enterprises with a variety of project styles and team sizes that are seeking to adopt more agile approaches. This article describes both the waterfall and agile project management methodology characteristics and the documentation processes in each method.

Documentation in the waterfall approach is characterized by comprehensive documentation that is built throughout the project. The author notes that in an agile

scenario, it is not necessary to include the same amount of upfront detail as the waterfall approach requires, and templates should have a structure that represents the key aspects that are appropriate for the style of project. Agile projects place a different emphasis on documentation, with agile favoring a “just enough” approach.

The author provides recommendations to apply the agile documentation practices into the waterfall methodology by using lightweight guidelines or templates documenting key aspects, tracking activity to avoid stale documents, and incorporating a schedule to review the documents as part of the project. The author notes that the application of agile documentation practices within the waterfall methodology is used to help communicate to non co-located project stakeholders, coordinate teams, archive key business decisions and changes, satisfy audit requirements, communicate to the business and executive teams, and provide system maintenance after deployment.

This paper is useful for the specific research study by outlining the various levels of content expected for documentation in the agile methodology versus the waterfall methodology. The author provides specific recommendations for leveraging agile documentation practices within traditional documentation practices in order to gain the benefits when producing the “just-right” amount of documentation needed by the project and business teams. This article provides best practices related to the specific topic of documentation within a blended project management approach.

Rahmamian, M. (2014). A comparative study on hybrid IT project management. *International Journal of Computer and Information Technology*, 03(05), 1096-1099. ISSN: 2279 – 0764. <http://www.ijcit.com/archives/volume3/issue5/Paper030535.pdf>

Abstract. Traditional Project Management Methodologies (TPMM) aim to prevent change by extensively planning and documenting as much as possible before the system is developed while change is inevitable and that it is not to be avoided. Additionally, Traditional Project Management rely more on processes, sequential software development, like waterfall. Consequently, there is a demand for system development methodologies and project management methodologies with the ability to adapt to a changing project and business environment. The aim of this study is to investigate hybrid IT project management that flexibly combining the traditional and the agile method; it emphasizes on two method of blending Scrum, an agile method, into traditional plan-driven project development and management such as waterfall or into structured and widely accepted project management methodologies such as Project Management Body of Knowledge (PMBOK). A comparison is then done of the two selected different hybrid methods.

Summary. This paper studies and compares two hybrid methods combining the agile and traditional project management methods. The first hybrid method presented uses an agile approach and the Project Management Body of Knowledge (PMBOK) Guide. Another hybrid model is presented applying an agile method, Scrum, into the traditional software development process. The paper reviews the agile, PMBOK, and traditional methods in IT project development and management. The hybrid model using the agile approach and the PMBOK methods embraces changes as often as needed. The hybrid model blending the Scrum method into the traditional plan-driven software development process starts with the traditional upfront planning method but uses the agile methods for design, implementation, and testing.

The presentation of the agile method elements, traditional method elements, and the two hybrid examples are useful for this research study, specifically in presenting the benefits of blending the Scrum method with the plan-driven method. The two benefits of this hybrid development that are particularly important are the up-front planning and specification of requirements and using the agile implementation methodology through phases or iterations. These benefits can reduce the risk of confusion of project objectives and deliverables; speed up the process of development; and reduce the risk of rework, delays, and rescheduling that we often see in the traditional development of projects.

Ryan, N. R. & Morris, M. G. (2014). IT project estimation: Contemporary practices and management guidelines. *MIS Quarterly Executive*, 13(1), 15-30. ISSN: 1540-1960.

Abstract. Many IT projects continue to suffer from poor estimation. Indeed, the accuracy of estimation has hardly changed from that reported in a seminal study carried out over 20 years ago. Based on findings from two recent survey-based studies, which replicated and then extended the original study, we provide guidelines for improving IT project estimation, taking account of the greater use today of Agile, rather than traditional Waterfall, development methods.

Summary. This article examines the practice of IT project estimation based on two different studies and provides recommendations to help project managers improve project estimation. The first of the two studies focuses on an organizational-level analysis of project estimation and the second study focuses on project-level data comparing waterfall and agile development methods with respect to estimation practices and project success. The second study is useful for this research study because it helps identify the usefulness and accuracy of project-estimation practices in the context of specific development

environments (agile versus waterfall development). Based upon the results of the study, the authors conclude that waterfall and agile projects employ similar estimation practices, with the exception of preparing formal estimates, which is more prevalent with the waterfall model. The authors offer specific recommendations for improving the accuracy of project estimates, including revisiting estimates throughout a project. Findings from the study comparing the waterfall and agile project management methods are that contemporary practices, including agile development methods, seem to be making some headway towards improving project estimates and ultimately success.

This article is useful for this specific research study because it compares the results of the survey based on the methods used to estimate project costs and the best practices of those methods for projects utilizing both the waterfall and agile methodologies. Waterfall projects tend to compare cost estimates with those of past projects, use individually prepared and reviewed estimates, and use established organizational standards, while agile projects are more likely to rely on expert judgment, formulas, and group-based estimates.

Špundak, M. (2014). Mixed agile/traditional project management methodology – reality or illusion? *Science Direct*, 119, 939 – 948. <http://dx.doi.org/10.1016/j.sbspro.2014.03.105>

Abstract. Project management methodology is usually defined as a set of methods, techniques, procedures, rules, templates, and best practices used on a project. It is commonly based on a specific project management approach that defines a set of principles and guidelines, which define the way a project is managed. With the growing trend of usage of agile project management on different projects, it is clear that two opposite sides exist – traditional and agile project management approach, and that there

exists a need to combine both approaches. So, the question is if it is and how it is possible to combine both approaches in a single project management methodology?

The paper covers thorough literature review and starts with the definition of the project management approach and of the project management methodology. It provides overview of different project management approaches and defines project management methodologies. The literature review shows what is considered as part of project management methodology in a wider or narrower sense, and what the main characteristics of a methodology are. The need for combining project management approaches is shown on the case of software development project.

The paper provides basis for further research on application of different project management approaches and methodologies. Further research could build on an idea of creating unique methodology for project, based on different project management approaches. In that way it is possible to create project management methodologies that have high possibility of customization to projects and to project environments.

Summary. This paper reviews the difference between project management methodology and project management approach. The author defines project management methodology as a set of methods, techniques, procedures, rules, templates, and best practices used on a project. The author defines project management approach as a set of principles and guidelines that define how a specific project is managed. The author defines the traditional and agile approaches in detail and describes the typical usage of the different approaches. The traditional approach is more appropriate for projects with clear initial user requirements and with clear project goals, therefore with very low level of uncertainty. The agile approach is intended for projects with a high level of uncertainty,

unclear project goals or incomplete and unpredictable requests, which could significantly change during the course of the project. The paper concludes that both traditional and agile approaches have their advantages and disadvantages and that it is possible to combine both approaches for a single project and within a single methodology. Practitioners who choose to blend the approaches will determine the appropriate methodology based upon the characteristics of each approach that are needed for the goals of the project team and the organizational environment.

This paper is useful for this specific research study because it describes the advantages and disadvantages between the traditional and agile approaches to project management. The paper provides recommendations for combining the traditional and agile approaches into a single project management methodology, including specific criteria for applying the blended approach based on finding the optimal number of appropriate methodology elements that will contribute to the project's success.

Conclusion

The waterfall project management methodology, also known as traditional or plan-driven, originates from the aerospace and other manufacturing industries (Paulus, Mohammadi, & Weyer, 2013) and was originally proposed by Winston W. Royce in 1970 to describe a possible software engineering practice (Bassil, 2012). The waterfall model is a sequential software development process in which progress is regarded as flowing increasingly downwards, similar to a waterfall, through a list of phases that must be executed in order to successfully build software (Bassil, 2012). These phases contain project tasks which are divided into a number of sequentially dependent stages with well-defined gates in between, one completed after the other (Bassil, 2012; Sommer, Dukovska-Popovska, & Steger-Jensen, 2013).

The waterfall model is comprised of five phases: analysis, design, implementation, testing, and maintenance (Bassil, 2012). Within each of these development phases are practices that support the development of trustworthy software. Trustworthy systems developed using the waterfall methodology are those that have stringent safety, reliability, or security requirements (Paulus, Mohammadi, & Weyer, 2013). Petersen, Wohlin, and Baca (2009) present the characteristics of the waterfall methodology that support trustworthiness by way of a case study to understand some of the perceived issues experienced using the waterfall method. The issues prioritized as critical and very important are related to the long lead-times of the requirements, the performance of testing late in the process where too much functionality is tested all together, and the resulting inability to provide fixes before implementation for issues that are discovered too late.

Implementing project management standards can improve efficiency in product development (Bassil, 2012; Sommer, Dukovska-Popovska, & Steger-Jensen, 2013). The

waterfall method fails on the following elements, thus impacting the efficiency of the development effort (Bassil, 2012; Sommer, Dukovska-Popovska, & Steger-Jensen, 2013):

- Processes: the processes are formal and often bureaucratic.
- Procedures: the procedures encourage specialization and formal decision-making.
- Structure: roles are well defined and rigid, stifling innovation.
- People: traditional project management is focused on systems rather than people.

Developing standards to be utilized by the project team can help reduce the impact of these issues on delivering a successful project (Sommer, Dukovska-Popovska, & Steger-Jensen, 2013).

The agile project management methodology is an iterative development process (Boehm, 2002; Fowler & Highsmith, 2001). Agile emphasizes continuous design, flexible scope, freezing design features as late as possible, embracing uncertainty and customer interaction, and exists in a modified project team organization (Serrador & Pinto, 2015). Initially, the agile methodology was perceived more as hacking, but agile is more about solving complex programming problems rather than following a plan and spending time thinking about the problems and how the development team might actually solve them (Boehm, 2002). Williams and Cockburn (2003) note that the agile methodology is not particularly new; software developers have been sporadically using the techniques since at least the 1960s. What is new is the bundling of the techniques into a theoretical and practical framework and the strong, sometimes vehement, declaration of their importance by agile proponents (Williams & Cockburn, 2003).

Each project development methodology has particular characteristics and shares the purpose of delivering products that meet the business need and support the process. A great deal of literature has been produced detailing how to successfully implement agile principles to

software development projects in order to achieve successful outcomes. Boehm (2002) identifies the characteristics of the key areas of the agile method as follows:

- Developers are knowledgeable, co-located, and collaborative;
- Customers are dedicated, knowledgeable, co-located, collaborative, representative, and empowered;
- Requirements are largely emergent and adapt to rapid change;
- Architecture is designed for the current requirements;
- Refactoring is inexpensive;
- Team and project sizes are smaller; and
- The primary objective is providing rapid value.

Fowler and Highsmith (2001) present the purpose of the agile methodology as a way of developing software by 'just doing it' and helping others with these values:

- Individuals and interactions over processes and tools;
- Working software over comprehensive documentation;
- Customer collaboration over contract negotiation; and
- Responding to change over following a plan.

The goal of the agile methodology, with the above characteristics and values, is to satisfy the customer through early and continuous delivery of valuable software (Boehm, 2002). The agile methods do require some upfront planning, significant communication, and collaboration with customers to provide project requirements for the first release, recognizing that more planning overall is performed in agile projects but is spread across the entire development cycle rather than performed up front (Serrador & Pinto, 2015).

Serrador and Pinto (2015) found that the more the agile methodology is used in a project, the larger the impact on the dimensions of project success; project efficiency (meeting the cost, scope, and scope goals) and overall stakeholder success (satisfying the expectations of project stakeholders who are the best judges of overall success). The agile process, if used thoughtfully, provides a clear mandate for making project planning and development practices lean and highly focused (Williams & Cockburn, 2003).

The blended project management methodology is the idea of combining the waterfall and agile methodology characteristics to manage projects more effectively. Waterfall project management is often best applied when the goal of the project and solution are clear and agile project management is often best applied when the goal of the project is clear, but the solution is not (Baird & Riggins, 2012). Several of the sources in the annotated bibliography provide examples of blended methodologies. Binder, Aillaud, and Schilli (2014) present the blended, or cocktail, project management model starting with an initial high-level plan, followed by detailed planning at each iteration, leading to the final implementation of the project deliverables. In parallel, a high-level monitoring of the project elements and dependencies between the deliverables produced must take place across iterations (Binder, Aillaud, & Schilli, 2014). Rahmanian (2014) presents a similar blended model starting with “waterfall-up-front” (p. 1099) to specify requirements and reduce confusion about project objectives and deliverables, followed by an agile method in the design, implementation, and unit testing phases to speed up the process and reduce rework, and completing the project with “waterfall-at-end” (p. 1099) for high-level testing and acceptance. Waterfall and agile methods can compliment each other and their combination can lead to innovative product development outcomes (Baird & Riggins, 2012).

Characteristics of a good methodology include (a) detailed necessary information, (b) usage of templates, (c) standardized planning, (d) time management and cost controlling techniques, (e) standardized reporting, (f) flexibility for usage on all projects, (g) flexibility for quick development, (h) ease of understanding for the user, (i) acceptance and use within organization, (j) use of standardized project lifecycle phases, and (k) guidelines and good business ethics as the base of the methodology (Špundak, 2014). Traditional project planning can be used as a catalyst to get the project moving in the right direction and to develop a strong backlog (prioritized lists of tasks or user stories that are waiting to be completed), but should not be expected to reduce unknown, potential bugs or shorten the duration of the project (Baird & Riggins, 2012). A blended process allows for greater flexibility and collaboration with “just enough” planning performed up-front and as each increment of the system is built, the team gathers input and learns from customer feedback (Hass, 2007).

Accurate estimates provide the foundation for effective project planning and execution, and, ultimately, project success (Nelson & Morris, 2014). The work breakdown structure is by far the most commonly used method for estimating project size and complexity in both the waterfall and agile methodologies, suggesting a formality and structure that has developed over time in project management (Nelson & Morris, 2014).

Another factor to take into consideration when utilizing a blended project management model is the determination of necessary meetings. Lozo and Jovanović (2012) suggest six types of meetings for the blended method: (a) traditional kick-off meeting; (b) traditional planning of milestones, schedule, scope, and acceptance; (c) sprint planning meetings; (d) regularly scheduled status meetings; (e) sprint reviews; and (f) traditional approval meeting. The

combination of meetings from the waterfall and agile methodologies supports the examples of the blended methodology provided in various sources.

Project documentation must be available to the project team, business, and users. Both the waterfall and agile methodologies have documentation practices and the amount required varies drastically. The waterfall method requires detailed documentation for each phase, whereas the agile method might not have any documentation for a given phase. Based on the characteristics of the blended project management methodology chosen, selecting the appropriate documentation templates that represent the key aspects of the phases of the project is necessary (McGovern, 2010). Comparing the documentation practices of agile and waterfall models side by side helps to identify that “just enough” documentation is present for the project team, business, and users (McGovern, 2010).

There are advocates for both the traditional and agile project methodologies. While the waterfall project methodology works well for projects with clear initial user requirements and project goals (Špundak, 2014), the methods pose challenges for large-scale project due to the difficulty of managing requirements or coping with change (Petersen, Wohlin, & Baca, 2009). Agile methodologies are successful in dynamic environments (Serrador & Pinto, 2015) and on projects with tightly coordinated teamwork and no more than a 15 or 20-person team size (Boehm, 2002), but agile also poses challenges due to the lack of documentation requirements and works best with co-located teams (McGovern, 2010). A blended methodology that garners strengths from both agile and waterfall approaches provides the ability to optimize the management of the different kind of projects (Lozo & Jovanović, 2012) and also incorporates the agility required to adapt to changing priorities and environments (Binder, Aillaud, & Schilli, 2014).

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