Methodological Framework for Virtual Team Project Management

A. Martinic, K. Fertalj, and D. Kalpic

***Abstract*—Virtual teams greatly depend on various information and communication technologies that support different aspects of teams' operation. Therefore, managing projects involving virtual teams requires specific tool and technology supported approach. Currently a number of project management methodologies exist, but none of them is entirely suitable for managing projects in virtual team environments. In this paper, a methodological framework suitable for management of projects involving virtual teams is proposed. Project life cycle adequate for virtual project teams is elaborated and effectiveness of the proposed framework is verified on a real-world project.**

***Index Terms*—Framework, methodology, project management, project processes, virtual team.**

I. Introduction

Virtual team can be defined as a group of people who use electronic means to communicate with each other more often than having face-to-face meetings [1]. It is the degree of online communication and not the dispersion of the team that characterizes a team as virtual [2]. Research dealing with virtual teams addresses various aspects categorized around lifecycle model that includes four general categories of variables: inputs, socio-emotional processes, task processes and outputs [3]. Research addressing virtual team project management mostly provides guidelines and recommendations regarding communication and collaboration [4], [5], utilization of tools and technologies [6], [7], and general project management principles and methods [1], [8], [9]. Some papers address usage of agile project management methodologies in virtual team environments [10]-[12]. There is general agreement that communication and collaboration aspects are the most important challenges in project management and project delivery. Researchers mostly emphasize the need for synchronous interactions such as face-to-face meetings, video and telephone conferences. On the other hand, some authors suggest minimization of the need for extensive team coordination by using standardization of project inputs, processes, and/or outputs [13].

Previous research typically provides recommendations for practicing traditional project management approach or agile methodologies in virtual team environments. The most common pitfalls of the traditional project management in virtual environments include: overemphasizing the project reporting aspect of project management, ineffective and inefficient communication, managing project inputs and outputs but not processes, reactive project management, and the lack of project repository [14]. Traditional project management approach has limited capabilities for adapting to changes and unplanned situations [15] that are even more likely to happen in virtual environments. On the other hand, most agile methodologies rely extensively on daily face-to-face meetings, and pay limited attention to planning activities [15], [16] that can be useful in reducing project uncertainty and misunderstanding among distributed team members. Furthermore, none of the existing project management methodologies specifically addresses usage of tools and technologies that are irreplaceable in virtual team environments [15]-[17]. To the best of our knowledge, there is currently no project management methodology specifically suited for managing projects involving virtual teams.

In this paper, we propose methodological framework tailored to support projects running in virtual team environments. The proposed framework is characterised by iterative approach, adequate planning, monitoring and control, supported with intensified utilization of software tools and information and communication technologies.

II. Project Management

A project is a temporary endeavour undertaken to create a unique product, service, or result. Uniqueness of the project causes uncertainties and project management ensures meeting the project requirements by application of knowledge, skills, tools, and techniques to project activities. Project management is accomplished through the appropriate application and integration of project management processes [18].

A project life cycle is a collection of sequential and sometimes overlapping project phases. Regardless of size and complexity, all projects can be mapped to generic life cycle structure as illustrated in Fig. 1:

- Starting the project
- Organizing and preparing
- Carrying out the project work, and
- Closing the project

A project phase is a collection of logically related project activities that result with completion of one or more deliverables. A phase may emphasize processes from a particular project management process group, but it is likely that most or all processes will be executed in some form in each phase. Project phase including all process groups is

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illustrated in Fig. 2.

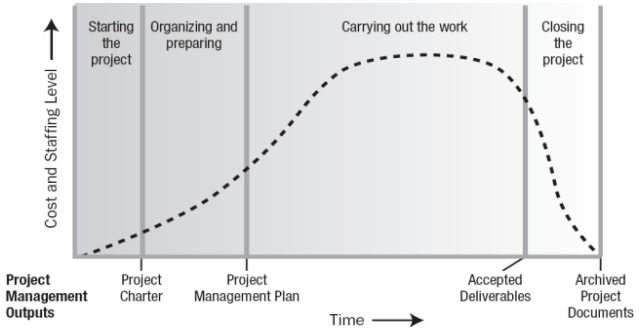

Fig. 1. Typical cost and staffing levels across the project life cycle [18]

The phase structure allows the project to be segmented into logical subsets and provides a formal basis for control. Each phase is formally initiated to specify what is allowed and expected for that phase. The beginning of a phase is also a time to revalidate earlier assumptions, review risks and define in more detail the processes necessary to complete the phase deliverables. The project phase is generally concluded and formally closed with a review of the deliverables to determine completeness and acceptance. There are three basic types of phase-to-phase relationships: (1) sequential, (2) overlapping and (3) iterative. Some projects may have only one phase, while other projects will have many phases. For a multi-phase project, more than one phase-to-phase relationship can occur during the project life cycle [18]. Methodology can be defined as a body of practices, procedures, and rules used by those who work in a particular discipline. Achieving project management excellence, or maturity, is more likely with repetitive process that can be used on each and every project. This repetitive process is referred to as the project management methodology [17]. Currently, a number of different project management methodologies are in usage. Three widespread approaches that have mostly influenced the development of proposed methodological framework include: (1) Traditional Project Management [15], (2) Agile Project Management [16], [19] and (3) Adaptive Project Management [15], [19].

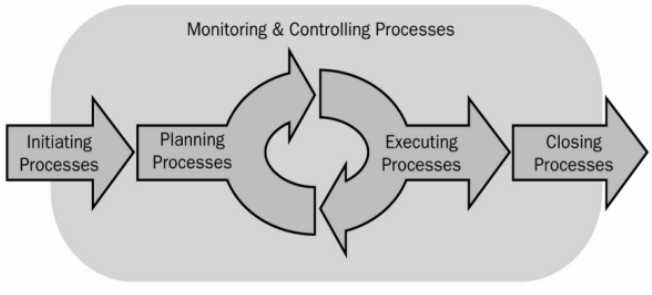

Fig. 2. Project phase structure [18]

III. Virtual Team Project Management Framework

Although there are numerous approaches to project management, none of the existing methodologies is entirely suitable for managing projects involving virtual teams. Traditional project management (TPM) has no efficient mechanisms to constantly monitor and control the projects, which can easily slip from planned course in distributed environments. This can happen because of uncertainties caused by team dispersion and intensive usage of less rich communication media. TPM cannot easily eliminate such uncertainties and cannot adequately adjust to frequent changes [19].

In uncertain, undefined and rapidly changing environments, minimization of risks and maximization of business value is achieved with an iterative approach [18]. Iterative approach is characteristic for agile methodologies. Agile approach promotes reduced planning limited to a single, forthcoming iterative phase. In virtual environments, reduced planning may decrease overall project awareness that may result with increased efforts required for project monitoring and control. The need for team members' interaction can also be notably increased. Agile project teams practice frequent, most often daily face-to-face meetings, and as such require co-location of team members in order to manage changes and produce increments [19]. Usage of agile methods in distributed environments requires significant transition effort, as well as intensive synchronous communication among team members [11], [12].

Among existing methodologies, adaptive approach such as Adaptive Project Framework (APF) [15] is the closest to be suitable for usage in virtual environments. APF is based on iterative planning in which mid-level Work Breakdown Structure (WBS) and functions prioritization is done initially, and more detailed planning and time scheduling is done prior to each cycle. Time spent on planning is optimized, since only the things that are certain are included in the plan. However, this approach may not be the best one for virtual teams. In the virtual team project initiation stage, it is necessary to clarify expectations as much as possible. Discussions on clearing goals and visions, definition of roles and indication of what is expected from each team member during each project stage, agreements on work organization and formalization of processes should take place on face-to-face meetings early in the project. Another positive effect of initial detailed face-to-face discussions is the improvement of personal relationships, mutual trust and team cohesion that consequently improve virtual team results [20]. All these can have positive effect in clearing vagueness that in later stages can cause significant problems resulting with delays lasting much longer than it would have been needed to conduct initial discussions on particular issues. Daily meetings conducted in APF are also impractical to carry out by virtual teams. Furthermore, APF promotes intensive interactions with the customer, which are not entirely suitable for virtual project environments. Another limitation of APF is the fact that it, like agile approach, promotes limited usage of software tools [15] that are otherwise the cornerstone of projects in virtual team environments.

Applying the appropriate project management approach is crucial for project success. The traditional management processes should be complemented with a more adaptive view. A hybrid approach to project management with both traditional and agile practices may be the most valid approach [19]. We find this to be especially true for projects in virtual team environments. As a result, the proposed methodological framework for virtual team project management combines the most suitable elements of the existing methodologies with

an addition of tool and technology support. The proposed framework is characterized by: (1) more detailed collaborative planning to reduce uncertainty and improve socio-emotional processes, (2) iterative project phases for reducing risks in virtual environments, (3) tool-supported monitoring and control with standardised inputs and outputs, unifying deliverables and intermediates, (4) customer approach adequate for virtual environments, and (5) intensified usage of information and communication technologies, compensating the lack of face-to-face interactions between team members.

A. Project Life Cycle

1) Project start-up

The proposed project life cycle begins with Project start-up, which includes definition of the project scope, project goals and related issues in collaboration with customer representatives. These activities should be mainly based on face-to-face interactions. In that way, the barriers and complexity introduced by distance are eliminated and project scope and project goals are most likely to be unambiguously agreed upon. It is not necessary for all the team members to participate in these initial activities, but as a minimum, the project manager and requirements analyst should be included. Such team members who frequently interact with the customer, should be located close to the customer premises [21]. In that way, organization of face-to-face meetings with the customer in this initial phase, as well as later on in the project, is fairly a simple task.

When the project scope and goals have been defined with the customer, an initial meeting of all the team members should be held. Although some studies suggest that the success of a virtual team project does not significantly depend on the technology used to conduct the initial meeting [22], based on the research of some other authors [13], [20] and on our experience, we suggest that the initial meeting should be held in the form of face-to-face meeting or at least as a video conference. Other forms such as telephone conference or instant messaging cannot ensure information transfer of adequate quality in this initial project stage. Exceptionally, they can be used on small projects or when team members have previously worked together and already know each other. At the initial meeting, the project scope and project goals are presented and discussed by all team members. Based on the discussion, an initial project plan is made. This plan should include elaboration of the project work in the form of WBS and time schedule. Team elaboration of the project scope and goals ensures that all team members understand what, how and when must be done. This reduces misunderstandings and decreases the need for frequent interactions during subsequent iterative phases. Team members get to know each other, expectations and possible problems are discussed, and common vocabulary is established. The elaboration of the project work in the form of WBS should be done to more details so that it would be clear to everybody what has to be done on the project. The time schedule is usually subject to later changes, so the initial plan can be made with fewer details, which can be defined and agreed during the forthcoming iterative phases. Even if this initial plan does change later on, the exercise is done and future planning activities should be more straightforward. Initial meeting conducted in the form of the face-to-face meeting is the most time and money consuming. Even then, its cost is relatively small, when compared to the cost of delays that can arise later in the project as a result of obscurities caused by the lack of initial planning and related discussions.

Although initial phases are quite similar in various methodologies [23], more detailed planning conducted in the Project start-up makes this phase closer to the traditional approach.

2) Iterative phases

Project start-up is followed with a sequence of iterative phases during which project deliverables are generated. Each iterative phase includes the following activity groups: (1) Iteration planning, (2) Iteration execution, (3) Iteration review, and (4) Customer review.

During Iteration planning, the existing plan is further elaborated, modified or confirmed, depending on the level of details planned in the Project start-up and on events that occurred during the previous iteration, influencing further course of the project. The result of the Iteration planning is a time schedule detailed enough so that specific tasks can be assigned to each team member. Some activities must be executed as collaborative work involving more than one team member. Although team members work concurrently to execute such activities, specific tasks must be clearly assigned to each team member. Each activity must have its inputs and outputs unambiguously defined. Iteration planning is a synchronous interaction in which all the team members must participate. Communication can be performed through face-to-face meetings, video or telephone conferences, or even by using instant messaging. Face-to-face meeting is the most time and money consuming. As such, it should be used only under exceptional circumstances, at the beginning of the project, or in the cases when geographical dispersion of team members is low. Having more details planned in the Project start-up, reduces the need for face-to-face meetings during iterations. If the initial plan agreed upon in the Project start-up exists, iterative planning can be efficiently performed using video or telephone conference. Some studies indicate that similar effects can be achieved with usage of instant messaging [22]. In our opinion, this form is not so efficient at the beginning of the project, but can be used as the project progresses, especially if previous iteration went according to the plan. Iteration plan agreed upon must be available to all the team members during Iteration execution. It should be visualized (e.g. as workflow, Gantt chart, etc.) and dynamically updated, providing daily insight into the current state of the project.

After Iteration planning is done, the work on producing project deliverables starts, and product oriented processes are performed. Processes as well as associated inputs, outputs and intermediates should be standardised as much as possible to reduce the need for frequent synchronous interactions [13]. Short daily meetings promoted by agile methodologies are not easy or even possible to perform in virtual team environments. This is especially true when globally distributed teams are in question. This drawback can be

compensated with intensive use of software tools for asynchronous communication (e.g. e-mail, workflow, wiki, etc.). These mechanisms must enable each team member to have an insight into activities of the rest of the team and to provide others with information about his or her status. At the beginning of a workday, each team member reviews project environment to obtain the most recent information about project status. Based on that information, a team member performs or adjusts his or her activities, and according to the work done, updates project environment with the own status. To support such approach, process inputs, outputs and intermediates must be standardized. Tools should provide as much automatism as possible, so these everyday activities do not become additional burden to team members. If issues requiring coordinated synchronous interaction of more team members occur, project manager defines necessary participants and selects appropriate communication media. More serious issues and conflicts require to use information richer media. Such media (i.e. face-to-face or telephone communication) enable users to communicate more quickly and to better understand ambiguous or equivocal messages [13]. The greatest distinction between the proposed approach and other agile approaches is the absence of daily face-to-face meetings. The absence of synchronous communication is compensated with tool supported asynchronous communication. If the absence of daily meetings is adequately compensated, duration of an iteration can be comparable to agile methodologies, ranging from one week up to one month. At the beginning of the project, when mutual trust and team cohesion is still being established, iterations should be shorter, and as the project progresses, duration of iterations can be prolonged.

Iteration review includes inspection of things that had been done in the iteration that has just finished. Work performed and deliverables produced are discussed among entire project team. Synchronous communication is subject to the same principles as in Iteration planning. In the beginning of the project, it is recommendable to use information richer media such as video conferences, and as project progresses, other means such as telephone conferences or instant messaging can be used as well. If communication issues specific to virtual environments are set aside, Iteration review is similar to other agile approaches.

In the Iteration review, customer is not directly involved for few reasons. Since virtual project environments carry greater risks, the produced deliverables first should be reviewed and validated within the team. In the case of shorter iterations, it is not always necessary to involve the client, as the customer representatives can become reluctant to participate so frequently. Furthermore, collocated face-to-face meetings for interaction with the customer should be used [21]. To conform to these conditions, customer inspection is a part of Customer review that may, or may not follow the Iteration review. In the Customer review, only a part of the project team may participate, and the rest of the team is informed about the results afterwards. In the case of some unexpected issues, further discussions are taken to the forthcoming Iteration planning. When all deliverables are completed and approved by customer, the Project close-out follows.

3) Project close-out

When thinking about activities that must be done, Project close-out is not very different from those in other methodological approaches [23]. Project results as well as lessons learned should be discussed, preferably on a face-to-face meeting. Video conference could also be a good and cost saving choice for globally distributed virtual teams. Storing project data in the knowledge base for future reference should receive special attention in virtual team environments. If the tools and technologies used are not properly set up, collecting and storing of the project data can be quite difficult. Information can be distributed among different team members and various data repositories. Project closing phases in all types of projects often receive limited attention [15]. If additional complexity is introduced by virtual environment, much potentially useful information may be omitted. To prevent that, a central repository must exist [14], and additional tools must be configured and integrated to store all project information meaningfully and automatically. If creation of knowledge base becomes a by-product of the project life cycle itself, efforts in this phase can be significantly reduced in comparison to the other project environments.

Our recommendation for usage of communication techniques and technologies throughout project phases is illustrated in Fig. 3.

Although the proposed methodological framework exploits agile principles, this does not exclude usage of project management processes. Agile project management should include selection of project management processes and application of agile principles on the selected process areas [19]. Having that in mind, our mapping of the proposed project life cycle to the five generally recognised project processes categories [18] is illustrated in Fig. 4.

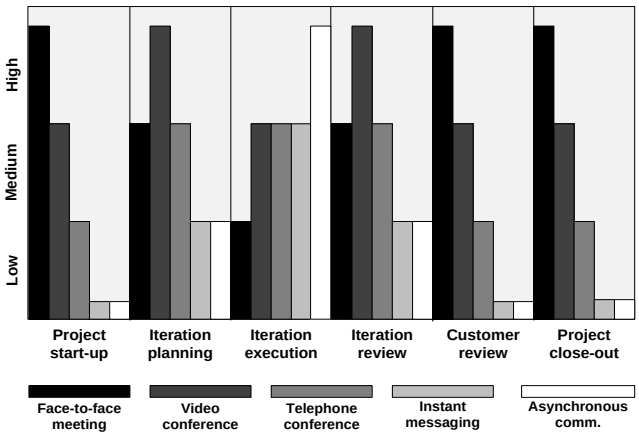

Fig. 3. Recommended communication techniques and technologies according to project phases

IV. Case Study

The efficiency of the proposed methodological framework was verified on a real-world software development project. The project team consisted of six members: project manager, business analyst and four developers. One of the developers was employee of an external organization. At the Project start-up, required functionalities were elaborated on a

face-to-face meeting with customer representatives. High-level time schedule was also agreed. Face-to-face meeting of the project team followed. Two developers were not available to participate on the initial meeting due to engagement on other projects. On the initial meeting, functional requirements were discussed and detailed time schedule was elaborated. Time schedule was made as if the project was performed with a collocated team, i.e. prolonged activity duration and other delays that could had been expected in virtual environment, were not taken into account. Document templates and coding conventions were used to standardize activity inputs and outputs. Iterations lasted up to two weeks. Due to relatively low team dispersion, Iteration planning and Iteration review were conducted as face-to-face meetings, or occasionally by phone if everything went according to the plan. Information was communicated with the external organization team member mostly by e-mail and/or phone. Customer reviews were conducted monthly on face-to-face meetings. During Iteration execution, scheduled face-to-face meetings were not conducted and communication and collaboration were supported by a shared repository, project management tool, issue tracking tool, e-mail, instant messaging and phone.

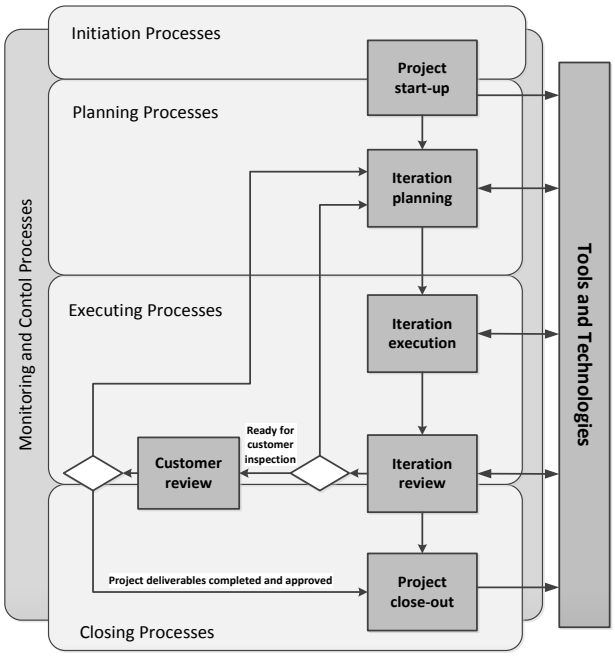

Fig. 4. Project life cycle

The project was successfully completed within anticipated boundaries. The absence of daily face-to-face interactions was adequately compensated and had no significant impact on the overall project success. Initial detailed collaborative planning showed to be beneficial, since two members that did not participate in the initial planning, later on required more interactions on clarifying issues, although they had been provided with all information as the other team members. Furthermore, detailed planning reduced the need for conducting and shortened the duration of synchronous interactions. When everything went as planned, the Iteration review was occasionally conducted over the phone, and Iteration planning included just a short overview and confirmation of the existing schedule. On the other hand, managing the same or related information in more than one tool turned out to be a problem since it required additional work, and caused inconsistencies that on several occasions resulted with unscheduled synchronous team interactions. Standardization of deliverables and usage of central repository simplified and shortened Project close-out phase when comparing to projects where these were not used. The limitation of the conducted verification is in that majority of team members, except the one from the external organization, were located within the same premises, so some contacts were possible outside the project setup.

These preliminary findings show promising results and indicate that the proposed methodological framework can be used for successful management of projects involving virtual teams. With the proposed iterative approach accompanied with adequate usage of tools and technologies, projects can be, at least, executed within the same quality, time and budget limits as projects with traditional collocated teams. Negative effects of virtual environments were compensated by iterative approach where frequent synchronous interaction was replaced by intensified usage of tools and technologies. We can assume that with increase of team and organization maturity, better integration of tools, and exploitation of other technologies (e.g. video conferences), even more efficient project execution can be achieved, so further research shall be conducted.

V. Conclusion

Although a number of project management methodologies exist, none of them is completely adequate for managing projects running in virtual environments. Therefore, by combining iterative and traditional approach accompanied by intensive utilization of tools and technologies, this paper proposes a methodological framework tailored for management of projects involving virtual teams. The proposed approach decreases the need for frequent synchronous interaction, while increasing of the project awareness consequently results in a more efficient project execution. The proposed methodological framework was verified on a real-world project, giving promising preliminary results. Some further improvements are identified such as better integration of tools and associated information. We presume that with such improvements an increased awareness would be achieved, while additional effort for managing information in various tools would be reduced. Future work will include development of architecture for integration of tools in heterogeneous environments inherent to projects involving virtual teams. With usage of such architecture in conjunction with the proposed methodological framework, further improvements can be expected.

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