The Concept of Project Management Platform using BI and Big Data Technology

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Abstract: In current world, organizations need to adapt to the changing business environment. They decide to conduct projects that result with new business processes, new products or services. Very often the goal of the project is to streamline specific area of company or a whole business. The projects become a very complex set of activities that require a sophisticated IT tools to support the efficiency of all the actions. Probably none single software application is able to handle every aspect of the project. That is why the authors decided to identify the kinds of software necessary for supporting the project and choose the applications that from their perspective can aid specific project activities. We have to remember that projects can generate a significant amount of data. If we are able to transform data into relevant information, we can maximize the possibility of success (both project and organization). In this paper authors propose the foundation of a complex platform supporting project management and execution with an emphasis on the analytical and reporting part by usage of Business Intelligence and Big Data technologies. Evaluation of such a platform is the subject for the future work.

1 INTRODUCTION

Nowadays organizations are facing new challenges. They run multiple project simultaneously to achieve various business goals. They also gain the experience from completed project that finished with a success, partial success or a failure. Enterprises require software applications to support every aspect of project management and execution. All those applications generate a significant amount of data. The data is stored in various IT systems in miscellaneous formats and very often in different locations. The effectiveness of the project decision-making is not resulting only from the amount of data collected, but also depends on the ability to the proper choice of sources of information. The speed of extracting the information is also crucial if we want to make the most successful decisions and limit the risks appearing in projects or regular business activities. The usage of advanced tools supporting the project management and reporting application very often based on the artificial intelligence seems essential to run a business, particularly in area of a project management.

2 PROJECT MANAGEMENT

Organizations decide to run projects when they want to (see (Burke, 2013)):

- deliver products or services to outside customers,
- increase internal efficiency by introducing the internal change.

Projects are activities in companies that have little (usually none) repeatability but a very high degree of complexity. Typically, those undertaken actions are related to the new (unique) activities that bring solutions for a new business situation or a problem. To achieve the effect, we must specify, among others, its duration and costs. We usually assign the author / owner / manager for those actions who is responsible for achieving the final result of the project.

The international organization consisting of companies and individuals interested in managing projects - Project Management Institute defines a project as a temporary activity that is undertaken to provide a unique product / service or achieve unique results (Kerzner, 2013). Z. Szyjewski believes that the project is a unique, non-routine process meeting specific targets in a given time by means of specific

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measures (Szyjewski, 2004) (see (Pondel and Pondel, 2011)).

Project can be also defined by indicating its individual characteristics. Various authors claim that a project is non-repetitive, time-limited and it has defined objectives. It includes various management methods and techniques. It solves new and previously unknown problems and it is associated with certain risks. Project must have a corresponding budget and during the performance of work, the project participants are under pressure (Kellner, 2001).

The basic attributes of the project include: location in time, uniqueness, complexity, purposefulness.

Project management can be defined as a set of managerial activities related to the implementation of projects and a set of used in these operations principles, methods and tools (Guide, 2001). Project management involves the application of knowledge, experience, tools, methods and techniques during the project activities, to achieve or even surpass the needs and expectations of stakeholders. Implementation of the project requires meeting many aspects, such as: scope, time and quality, various needs and expectations of stakeholders, identified and anticipated requirements, risks and their neutralisation plans.

Modern organizations to streamline their operations and project management, use the access to various electronic information resources. Multitude of available information and the diversity of sources make the decision-making more complex. We should take into account such factors as: reduction / extension / asymmetry of time and information and the responsibility of many people for making decisions (various locations of the company). At each stage of project in companies we can identify many of the key elements that influence the success of the whole project execution. All this encourages companies to investigate and use different types of IT tools that allow to facilitate efficient decision-making process.

Managing the project, we have to be aware that it requires the efficient communication and proper relationships management. Those relationships exist (Kerzner, 2013):

- within the project team,
- between the project team and the functional organizations,
- between the project team and senior management,
- between the project team and the customer's organization, whether an internal or external organization.

3 SOFTWARE SUPPORTING PROJECT MANAGEMENT

According to many sources we can divide the software supporting project management into the following groups (see (Rus and Lindvall, 2002), (Wikipedia, 2015)):

- Collaborative software,
- Issue tracking system (ITS),
- Planning / Scheduling,
- Project Portfolio Management,
- Resource Management,
- Document Management,
- Workflow system,
- Reporting and Analyses.

Team collaboration is essential for the success of projects. When team members are spread across different locations, individual awareness of the activity of others drops due to communication barriers (Hattori, Lanza, 2010).

Collaboration software is designed to improve productivity of individuals, teams and organizations. This is achieved through the following capabilities of collaboration software (see (Hildenbrand and Rothlauf and Geisser and Heinzl and Kude, 2008)):

- informing,
- coordinating,
- actually collaborating,
- cooperating.

Issues are common part of every project. They may appear on every stage and requires the actions leading to its successful resolution.

An **issue tracking system (ITS)** is a software application that allows an enterprise to record and follow the progress of every problem or "issue" that a team member identifies until the problem is resolved. With an ITS, an "issue", which can be anything from a simple customer question to a detailed technical report of an error or bug, can be tracked by priority status, owner, or some other customized criteria.

An ITS provides the user with a way to report an issue, track progression towards its resolution, and know who is responsible for resolving the issue. It also allows the manager of the system to customize the tracking procedure so that unnecessary documentation on the part of the problem solvers does not become a waste of time. Many kinds of enterprises use ITS applications, including software developers, manufacturers, IT help desks, and other service providers (Techtarget, 2015).

Planning is determining what is necessary to be done, who should be responsible for the task, and when the task should be completed to fulfil defined

requirements. We have to consider the following element of planning (see (Kerzner, 2013)):

- Objective – a goal to be achieved.
- Schedule – a plan defining in what point in time the activities will be started and when they will be completed. It shows also the resources assigned to the task and people responsible for task successful execution. In the schedule the references and dependencies between activities must be also presented.
- Budget – planned expenditures required to achieve objectives.
- Forecast – a projection of what will happen in a certain moment in time.
- Organization – a list of position of team members with corresponding duties and responsibilities required to complete defined tasks.
- Standard – a level of individual or group performance defined as adequate or acceptable.

We have to be aware that planning is based on forecasting and the uncertainty is involved with planning in an inseparable way. That is why planning is a continuous process of making decisions and organizing the effort needed to carry out these decisions. Planning must be based on monitoring the completed tasks and designing the future in order to achieve goals. If the systematic planning is not effected, it ends up with reactive management leading to crisis management, conflict management and firefighting.

Software supporting **planning and scheduling** often use a project structure to describe a given project. A project structure maps real-world aspects of a project, such as timelines and tasks, into an electronically accessible format. For example, many project development systems describe a start, finish, and other schedule dates of a project, the tasks that are performed and the results that are achieved during the project, and the data objects that are generated by the project or used to complete the project. A Gantt Chart is an example of a project structure that can be used to describe a given project. A Gantt Chart is a graphical representation that shows the time dependency of several tasks of a project within a calendar. A Gantt Chart provides a graphical illustration of a schedule that helps to plan, coordinate, and track specific tasks in a project (Meyringer, 2006). Gantt Chart is most commonly used in a software supporting project planning.

The ultimate goal of **Project Portfolio Management** is to maximize the contribution of projects to corporate success. Thus, PPM can be considered as the simultaneous management of the collection of projects that make up an investment strategy of a company (Heising, 2012). Project Portfolio Management is about more than running multiple projects. Each portfolio of projects needs to be assessed by its business value and adherence to strategy. The portfolio should be designed to achieve a defined business objective or benefit. Project management guru Bob Buttrick summarised it when he said; Directing the individual project correctly will ensure it is done right. Directing 'all the projects' successfully will ensure we are doing the right projects (Projectsmart, 2015).

The most important features of Project Portfolio Management Software are:

- project evaluation process or methodology,
- cost and benefits measurement,
- progress reporting,
- communication of key project data, for example executive dashboard,
- resource and capacity planning,
- cost and benefits tracking.

Resource management software is supporting users in following tasks (see (Kerzner, 2013)):

- Resource levelling is an attempt to avoid the manpower peaks and valleys by smoothing out the period-to-period resource requirements.
- Resource allocation which is an attempt to find the shortest possible critical path based upon the available resources.

During every project execution a number of documents appear. Document management systems are essential to store, share, search and protect the documents. Some of the key features in document management include:

- Check-in/check-out and locking, to coordinate the simultaneous editing of a document so one person's changes don't overwrite another's.
- Version control, so tabs can be kept on how the current document came to be, and how it differs from the versions that came before.
- Roll-back, to "activate" a prior version in case of an error or premature release.
- Audit trail, to permit the reconstruction of who did what to a document during the course of its life in the system.
- Annotation and Stamps.

Workflow systems are considered mainly as tools supporting business processes. A workflow application implements a business process model. The model describes the process steps to be performed to achieve a specific business goal, business rules for coordination of those steps and responsibilities of process participants (Schmidt, 1998). The steps include tasks that should be

performed by agents that can be human, computer systems or combination of both (Demeyer, 2010). Workflow systems, with the benefits of efficient and flexible process modelling and process automation, have been widely used for managing business processes. Although the business process and project are two different subjects (business process is repetitive and project goal is always to create the individual deliverable) the stages or tasks in projects can be treated as a small process that should be executed according to the business rules defined in a workflow tool eg:

- Document approvals - business rules define who is responsible for creation and approval of documents. Every kind of document can have individual list of approvers.
- Change management – the workflow can define how the change should be identified, described, estimated and who should be responsible for its approval and execution.
- Risk management – the workflow can enforce the specified risk description by a project manager and can lead the process of execution of preventive actions.
- And many more.

Reporting and analyses are essential when we would like to control and monitor all aspects of the project execution. We can rely on a reporting modules of mentioned software to prepare simple analysis (usually as tables or charts) presenting the information from one area of project management and execution field. We can also use Business Intelligence tools that could integrate the data from all the systems used during project and present the holistic reports. Regarding Business Intelligence tools we can distinguish 2 main approaches:

- traditional BI based on ETL Process, data warehouses, data marts, OLAP, dashboards, scorecards and analytics,
- Self Sevice BI where Power Users connect to various data sources and create their data models on which they build visualisation layer.

Authors believe that for more sophisticated purposes also the techniques called Big Data can be useful in a project management.

4 THE CONCEPT OF SOFTWARE PLATFORM SUPPORTING PROJECT MANAGEMENT

As it was mentioned in the previous chapter we can distinguish several roles that PM software can play and there is a number of software applications between which we can choose the most efficient and convenient tools.

Depending on the project specifics, we can define different criteria of PM tools selection. For a purpose of this paper we will take the following assumptions:

- we will focus on IT projects,
- a platform must support not only individual project but a number of projects that are conducted in the organization,
- a majority of project team members are office workers, but we can meet also handworkers dealing with hardware installation, computer network construction, inventory delivery,
- a significant portion of project members and stakeholders are mobile workers who travel a lot and use mobile devices for professional purposes.

Taking into account those conditions authors will try to choose the list of IT systems that will meet the following criteria:

- They have an open API to allow integration with other items of the platform.
- They are portal solutions – allow access through the Internet Browser.
- They are can be hosted in cloud environment.
- They should provide the mobile access to their features.
- They should support the world wide standards (eg. most common files formats, ways of data presentations).

The proposed solution is aimed to be a comprehensive platform that can support every single aspect of project management and execution.

While choosing the software tools authors followed previously defined criteria, their own experience, popularity of software tools, ability to integration with previously selected tool and available description of chosen tools. Authors do not claim that every chosen software product is the best in its category. For sure the discussion about better selection of tools could be initiated.

For collaboration and document management platform authors chose the services being a part of Microsoft Office 365 Platform. Those are cloud services that contain: Yammer – the world leader of social software, MS SharePoint – the platform for document management, MS Exchange that provide the features for business email, calendars and task management, Skype for business that is unified communication platform providing such features as: IM, audio and video calls, online meetings and sharing. Authors decided to use those software tools, because they are compatible with MS Office which is

the most common tool for document creation. This platform is also considered as a world leader in Social Software (Gartner 2015). It also includes a number of features that together constitute the unified platform for collaboration, communication, information management and document management. It is possible that we could find in every single area some specified product that could be in some criteria better that those chosen, but in would require integration with the rest of tools. In case of Office 365 those tools are already integrated.

Table 1: The list of software tools constituting the holistic Project Management Platform.

Type of software	Chosen IT system
Collaborative software	Yammer, MS SharePoint Online available in MS Qffice 365, MS Exchange online, Skype for Business
Document Management	
Workflow system	MS SharePoint Online with Nintex Workflow and Nintex Forms for Office 365
Issue tracking system (ITS)	Atlassian Jira
Scheduling	MS Project
Project Portfolio Management	MS Project Online
Resource Management	
Reporting and Analyses	Data Warehouse: MS SQL Server Business Intelligence, BI / Self Service BI: QlikView, MS PowerBI Big Data: Hadoop MongoDB Pentahoo Business Analytics

Authors decided to build the workflow platform also on SharePoint to keep the consistency of tools. Microsoft platform contains the Workflow engine available to SharePoint. Unfortunately, in its original form it is difficult to be applied so authors chose the application for modelling and maintaining the processes called Nintex for Office 365. That include the tool for process automation (Nintex Workflow) and a forms designer application (Nintex Forms).

For issue tracking and task management in project authors chose the Atlassian Jira Software that allow:

- Planning tasks and assigning them to project members.
- Tracking the work of team members.
- Collaboration and communication in terms of assigned tasks and issues.
- Creating workflows automating tasks and issues execution.

Jira was chosen because its large functionality and existence in many rankings on top positions eg. Gartner considers Atlassian products as one of the leders in his Magic Quadrant for Application Development Life Cycle Management together with IBM and Microsoft Products (Atlassian, 2015). We must add that Jira is used not only in software development projects but also in many more types of projects.

We can observe that some features in Jira exist also in Microsoft Office 365 Platform. Authors assume that the collaboration and information management on a management level will be performed in the Microsoft Office 365 platform. The task management on a project execution level will be performed in Jira. Moreover, in the specific areas those platforms must be integrated to provide a consistent tool useful for both managers and project team members.

Regarding the Scheduling on a managerial level and also project portfolio management authors propose to use the Microsoft platform that consist: MS Project Professional Application for scheduling purposes and MS Project Online which is an EPM (Enterprise Project Management) tool allowing the management of whole Project Portfolio. Together with portfolio management this platform includes the resource management capabilities. It is directed to project managers, project stakeholders and the management personnel involved in the project. This platform requires integration with task and issue tracking system (Jira) which is directed to project executors. The integration has the following aims:

- Convey the information about scheduled actions to Jira and assign specific tasks to the team members.
- Inform back the Project Management Platform about a current state of assigned tasks.

The diagram visualizing the concept of the platform is presented on the Figure 1. It doesn't include the reporting and analytical platform that will be described in the next chapter.

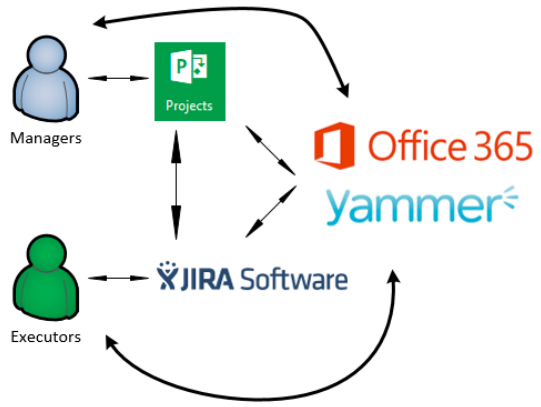

Figure 1: The concept of Project Management Platform.

4.1 Reporting and Analyses

In a project management processes and portfolio management decision making is an immanent activity of managers, project owners, stakeholders and sometimes also project executors. That is why analytical platform can have a crucial meaning in making decision regarding Project and Project Portfolio. Those decisions regard among others:

- scheduling,
- resources utilisation,
- risk management,
- approvals,
- technological decisions.

Fundamental assumption of an analytical system in a Project Management Platform should be provision of targeted information for every layer of its users. That is why we propose to build the analytical tool based on a 3 pillars:

- Data warehouse with a regular BI system,
- Self-Service BI platform,
- Big Data platform.

Authors decided to base a data warehouse on a Microsoft SQL Server capabilities that can used as on-premises solution and also the cloud service hosted in MS Azure can be used. The presentation layer for the Business Intelligence system can be the MS Power BI application that is part of Office 365 so it is consistent with the other components of platform. However, authors recommend using also other ways of information presentation like QlikView which is the leading tool for data analytics and visualisation.

In the BI platform we would gather data from every component of our Project Management Platform and allow to analyse the following characteristics:

- Project Portfolio Management - Data regarding project characteristics, timelines, objectives and deliverables.
- Scheduling - Data describing the timelines and the progress of the project and influence of the materialised risks on the project schedule. Also the changes in project timelines. They include also financial data and the project efficiency.
- Resource management - The estimations and real resources utilisation. The resource characteristics. The references between resource skills and their efficiency.
- Document Management - Document metadata (dates of creation, authors, dates of modifications, etc.).
- Issues and Tasks Tracking - The amount of issues and tasks at specific stage of the project, the resource consumption during tasks execution and issues solving, the types of issues.
- Workflow - The current progress of every process, planned dates of process completion.
- Collaboration support - The number of topics discussed during project planning and execution.

The analysis available on this layer would be directed mainly to the portfolio managers, project managers and whole management personnel. Sometimes the specific analysis describing specific project of specific resource efficiency would be useful for the team members.

Self-Service BI platform would be directed mainly to project managers. As mentioned earlier the aim of the project is to deliver a unique product or a service that is why every project has its own individual specifics and characteristics. Looking from this perspective we should be aware that it may be impossible to build a universal data warehouse that can cover every specific information requirement. That is why the BI tool that enables creation of specific and individual reports would be very useful in such case. It can be based on the same tools mentioned above.

Regarding the Big Data platform, it can bring the benefits mainly to project managers and team members. We assume that Big Data mechanisms can store mainly the information about all events in the Project Management Platform which can be:

- The statistics about accesses of every team member to every component of the platform. Such analysis can confirm if the project executors possess the sufficient information about the project characteristics, decisions, assumptions and boundaries.

- The changes in documentation and the influence of document lifecycle on the project.
- The issues descriptions and comments of employees providing resolutions can give us knowledge helping risk management.
- Data describing events appearing during process execution. Natural language comments analysis may give us valuable knowledge.
- Media appearing during collaboration, text content of discussions, findings, commitments, conclusions and their influence on the project execution.

Those events should be gathered by event hub mechanism and feed Dig Data repository and trigger user notification if applicable. As described the Big Data platform store mainly unstructured data and we can expect that the amount of the data can exceed the abilities of relational databases to efficient processing (especially in the organisation where a number of projects are executed at the same time and there is a significant number of historical projects that also consist a valuable data). Analysis of events happening in historical project together with the findings and observations relating to the corresponding projects bounds to bring managers the valuable knowledge allowing:

- streamlining the projects efficiency,
- avoiding or minimalizing the risks,
- improving the quality of deliverables.

Being aware of the assumptions and expectations directed to the Big Data platform authors propose to build it using the common technologies like:

Hadoop - framework that allows for the distributed processing of large data sets across clusters of computers using simple programming models. It is designed to scale up from single servers to thousands of machines, each offering local computation and storage (Hadoop, 2015). In our case Hadoop will improve the performance of the system storing a large dataset from a number of projects.

MongoDB - it is an open-source, document database designed for ease of development and scaling. It is one of the most popular and appreciated NoSQL Databases management system and it is positioned by Gartner Magic Quadrant as a Challenger (Mongodb, 2015). MongoDB is equipped with MongoDB Connector for Hadoop what allows to pull MongoDB data into Hadoop Map-Reduce jobs, process the data and return results back to a MongoDB collection.

Pentaho Big Data analytics tools allow to extract, prepare and blend the data. It includes the visualizations and analytics capabilities. It contains: data ingestion manipulation integration, enterprise and ad hoc reporting, Data Discovery and visualisation and predictive analysis. Pentaho Big Data is capable to communicate directly with MongoDB database.

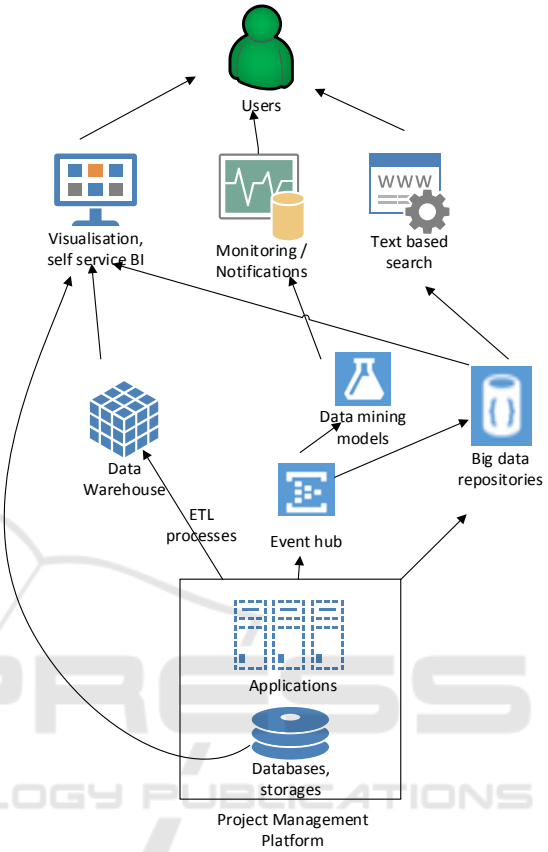

Figure 2: The concept of Project Management Platform.

Presented on a Figure 2 concept of BI / Big Data analysis is a general level considerations of authors and needs to be verified and evaluated during the next stages of research. The highest benefits that authors predict of such approach are:

- Management information visualisation
- Event analysis related to project team communication, collaboration or documentation lifecycle resulting with real time alerts that warn against possible risks and possible project issues. Those alerts are based on data mining based analysis that recommend undertaking of specified actions to avoid predicted problems that may impact the project's success
- Large text sets analysis allowing to search for sufficient project information across all heterogenic systems and applications

5 CONCLUSIONS

The Project Management processes require adequate software applications that together should act as a seamless platform supporting all the actions that can be undertaken. It is essential those applications to communicate and together bring the value to the final users and project stakeholders. It is also crucial to have experienced people that manage and execute the project. In the modern enterprise environment, where a number of projects are executing at the same time a proper data collection and processing seems also essential. Modern techniques of collecting and processing data can benefit for the decision making during the project especially in areas of risks identification, better resource workload estimations, more adequate planning and information and knowledge sharing. The experience gained during project execution is also helpful for improving efficiency of the future projects. Authors of the paper claim that the Business Intelligence tools and Big Data analysis can provide Project Managers, stakeholder and regular team members with a very valuable information and knowledge. Authors proposed the list of software applications that can support the project management processes with a special emphasis on a reporting and analytical capabilities. The future research will contain identification of more detailed Project Management use cases that can be improved by proposed platform. Authors will also focus on empirical verification of effectiveness of proposed platform. Authors are going to investigate every single item of the platform but also want to focus on the evaluation from the holistic perspective.

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