

**Metadata-Based Project Management System. A Case Study at  
M-Files Corporation**

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Project management is nowadays the leading activity in any organization, regardless of organization size and business area, among other factors. One of the prerequisites for an effective project management has recently become the use of advanced project management systems and tools based on new information technologies and approaches. However, there are still few project management systems which address most of the needs of an organization.

Metadata is used in various knowledge areas, although its value and importance is still underrated. A small number of software products are taking advantage of its abilities and none were found in project management domain. However, a case study at M-Files Corporation has shown that the metadata-driven architecture used for enterprise content management also allows managing various types of project management related entities.

The purpose of the thesis was to develop and investigate a new metadata-based project management solution based on M-Files technologies. By the end of the implementation phase, the new solution was consisting of a metadata structure suitable for project management, automation functionality to facilitate the routines of the project manager, and analytical features to avoid the manual work required to analyse the different aspects of project management and implementation.

Considering that at the time of writing the thesis, the new project management system was in deployment for only two months, some interesting results were still discovered. For instance, some organizations reported that they achieved a better performance by cutting down certain time-consuming, yet obvious activities, which was possible due to the metadata advantages. More than that, they are expecting an even more increased efficiency by using the analytical features of the new project management system.

Key words and terms: project management, project manager, project management knowledge areas, project management software system, metadata, case study, M-Files

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## **1. Introduction**

Project management is nowadays a leading activity in any organization. With the growth of organizations, the projects also become more complex and the managing process becomes more challenging and demanding. In addition, the intensive growth of information and communication technologies in the past few years, along with the current social and economic tendencies in the global economy, have led to a creation of qualitatively new requirements for planning and managing projects in various economical fields.

The implementation of any of the present-day projects is hard to imagine without the use of dedicated project management software, regardless of the business area, the composition of the project team, the amount of team members, budget, goals, and objectives. More than that, in the recently developed project management software, more emphasis is given to the project management standards, such as the Project Management Body of Knowledge. However, the development for this kind of software, based on new approaches and technologies, is still high in demand.

The current market of project management software solutions provides various products, which tend to meet the changing requirements in project management and their integration to the information technology domain. However, the number of the solutions which would address the variety of the knowledge areas and the uniqueness of every project is rather small. This is true due to the certain limitations the existing software systems have.

Metadata is a type of information that is met in nearly all type of knowledge areas, used in various scopes and functions, and still the value and importance of it is underrated. Nonetheless, if deployed in a proper way, metadata can bring a great benefit for the purpose it is used for. A proof of its successful usage are the metadata-driven enterprise content management solutions developed by M-Files Corporation.

Considering an internal case study at M-Files, it was discovered that enterprises use the content management system far beyond the document management. They also effectively adopting the metadata for certain project-related matters. However, the current system was lacking some of the common features present in other project management systems.

The purpose of this thesis is to develop and analyse a new project management system based on metadata-driven M-Files technologies along with the most required features for project management. The result of the implementation is a highly-customizable metadata architecture, suitable for a wide range of business areas. In addition, certain automating and analytical features were implemented, intended to help the project manager in his or her routine management tasks. The analysis includes an interview with a Senior Manager at M-Files Corporation regarding the deployment and usage of the implemented system, as well as a qualitative comparison of previously used and the new system.

The thesis is divided into 7 chapters, each one beginning with a brief introduction of its own content. Next after this introduction, in Chapter 2 the project and project management aspects are reviewed, based on the Project Management Body of Knowledge. Some of the aspects discussed, are the different approaches to the project and project management definitions, the characteristics and the phases of the project, in addition to the roles and responsibilities of the project manager. This chapter also discusses the Triple Constraint and the project management knowledge areas. In Chapter 3, two of the most used project management tools are reviewed with regard to the project management aspects. Chapter 4 is dedicated to metadata, its definitions, categories, principles and functions. In Chapter 5, the related M-Files technologies are reviewed and a case study about the project management with the previously used solution is analysed. Chapter 6 focuses on the implementation and evaluation of the new project management system. It starts with an overview of the metadata structure and the features implemented, continues with a comparison with the project management systems discussed in Chapter 3 and finishes with the analysis and findings based on an interview conducted in the company. Finally, Chapter 7 concludes the thesis by summarizing the findings, mentioning the limitations and discussing the recommendations for further work.

## 2. Project Management

Nowadays, project management is one of the globally recognized professional activity. Various project management methodologies and approaches are used in all types of knowledge areas, types and sizes of organizations. The development of project management, as a professional area, turned it into a powerful tool for managing the development of new products and services, as well as for managing the implementation of organizational changes within companies or entire social and economic systems. These factors, make project management one of the most important activities at present.

The main difference between project management and general management is related to the definition of a project and what the project intends to deliver to the customer. Thus, this chapter will begin with the project definition and its characteristics, and will continue with the definition of project management. Since project management is a wide area of knowledge, this chapter will also include reviews of the main project management entities as project phases, the Triple Constraint, the project manager and his roles and responsibilities. Furthermore, some of the project management knowledge areas are described.

### 2.1 Project Management Definition

A well-established definition for project can be considered the one given by the Project Management Body of Knowledge, where project is defined as a temporary endeavour undertaken to create a unique product, service, or result [PMI, 2013]. A project is called temporary because it has a fixed start and end, and not because it is short in duration. The end of the project is reached when the scope of the project has been implemented, when under certain circumstances the scope cannot be achieved, when the project outcome becomes needless, or when the customer decides to terminate the project. According to Schwalbe [2011], the end, in turn, has several criteria for measuring the project success:

- The project succeeded if it met the Triple Constraint (scope, time and cost goals).
- The project succeeded if by its end, the customer is satisfied. There might be cases when the Triple Constraint is not met, but for some reasons, the customer is happy. An example of such reason can be the attitude of the project members to the customer. The project can be successful if team members were very polite and they helped users in work-related problems, among others.
- The project succeeded if the outcome met the main objectives. In some cases, the customer might still approve the project outcome if he or she is happy with the result, even if the project cost turned out to be more than estimated, the deadlines were overdue or/and the members were hard to work with.

Another definition of project is given in PRINCE2 methodology, where a project is defined as a temporary organization that is created for the purpose of delivering one or more business products according to an agreed Business Case [PRINCE2, 2009]. Business Case, in the context of PRINCE2, is an essential document that contains the grounds for the project and which is referred to in an iterative manner to ensure that the project is still viable. Business Case is a part of the project initiation and is considered as a key driver in any project which adopted PRINCE2 methodology.

In order to meet the goal of the project knowledge, skills, tools and techniques are applied to the project activities. This application of knowledge is called *project management*. Main activities in a project management include the following:

- Requirement elicitation.
- Considering various needs, concerns, expectations from stakeholders regarding the projects.
- Maintaining an active communication with stakeholders.
- Preparing stakeholders for fulfilling project requirements and deliverables.
- Stabilize the project constraints: scope, quality, schedule, budget, resources, and risks.

## 2.2 Project Characteristics

The main characteristic feature of a project can be one of the following:

- New product, service or result development.
- Organizational model, processes, staff or style change implementation.
- Information system (hardware or software) acquisition.
- Research results competently recorded.
- Building, industrial plant or infrastructure construction.
- Business processes and procedures implementation and/or improvement.

The outcome of most of the projects is long lasting. This is because the outcome is usually a product, a service or a result, which is expected to be used and/or is useful for a long period of time. In other words, the outcome of a project can be one or more from the following list:

- A product that can be a component, an enhancement of another product or a completely new product.
- A service, an ability to execute a service or an improvement to a service.
- A result in a form of a document (e.g. research projects).

The outcome of any project is a unique one. However, the activities to achieve the goal of the project can be repetitive, based on established processes in the organization. Nonetheless, there are always different and/or new procedural elements, which make the result of a project exclusive.

The main features of a project according to PRINCE2 are the following:

- **Change.** Depending on what the outcome of the project is, it will impose changes to the information system (e.g. software/hardware development), environment (e.g. building or other construction), and organization (e.g. implementation of a business process), among others.
- **Temporary.** As well as in the definition given by PMI [2013], the project shall have defined start and end points.
- **Cross-functional.** This feature means that a project often involves people with different skills, from different areas of knowledge, and different organizations.
- **Unique.** Similarly to the features stated by PMI [2013], PRINCE2 is stating that the outcome of a project is unique. Even though, some project outcomes might be somehow similar to others. For instance, if a new version of a software is developed, it might not completely change the initial software, but it will still be different.
- **Uncertainty.** The above-mentioned features, introduce various unpredicted risks, which makes the project uncertain about the outcome.

### **2.3 Project Phases**

In order to ease the project management, planning and monitoring the project may be segmented into logical subsets, also known as phases. According to PMI [2013], a project phase is a collection of logically related project activities that culminates in the completion of one or more deliverables. A project can be divided into phases when during its implementation, specific major deliverables have to be developed and the work to be performed is unique to each phase.

According to PMI [2013], there is no standard structure or practice to divide the project into phases. However, there are industry-specific recommendations on how to partition a project, there might be significant variations, even in an organization.



Some organizations consider the nature of the specific project and project team organization, so they allow the teams to decide about project phases and/or other related project management issues. This results in various approaches of project segmentation into phases. Nonetheless, a common practice is to divide the project into 6 phases. A schematic representation of 6-phases sequence and main point of interest for each process is represented in Figure 1.

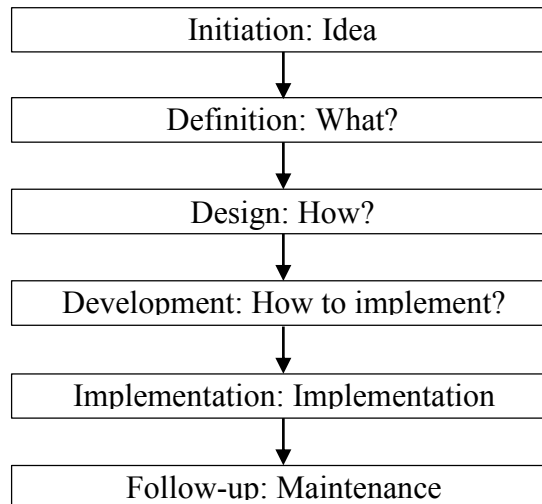


Figure 1. Six project phases and their main points of interest [Baars, 2006].

*Initiation phase* is the beginning point of time of the project. At this point, the idea and feasibility of the project are elaborated and examined. In addition, several questions should be answered at this phase, in order to move to the next one [Zarenkov, 2010]:

- What should the outcome of the project be?
- Is the project possible to realize?
- Who will implement the project?
- Who will sponsor the project?
- How to make the project awarding and appealing for the sponsors?

When the questions in the initiation phase are answered, and the analysis of the answers result in a positive feasibility and profitability of the outcome, the project enters the *definition phase*. Definition phase is the stage when the amount and type of work is specified, and time and resources are considered and estimated. At this point, the requirements and scope of the project are specified and documented as clearly as possible. In other words, the goal of this phase is to define all the required work, in a way that all the involved parties clearly understand what exactly they have to do, to what extent and when.

The scope and requirements documents created at the definition phase can be used to identify various design options for the outcome. The project phase, when different options for the outcome are created, is called the *design phase*. At this point, it is highly recommended to collaborate with other project stakeholders in order to decide about the final design of the outcome [Baars, 2006]. This is recommended, as changing the design choice in a later stage implies returning back to one of the early stages of the project.

After the design choice has been made, the project enters the *development phase*. It implies deciding upon everything that will be needed to achieve the project outcome. For instance, the schedule and costs are planned, suppliers or subcontractors are brought in, materials and tools are ordered, and tasks are distributed to the team members.

Next, after everything is arranged and planned, the actual implementation starts at the *implementation phase*. At this point, all the planned work is carried out in order to reach the project outcome. During this phase, the outcome becomes visible to the stakeholders who will be involved in the evaluation of the outcome. Evaluation of the project outcome is based on the scope and requirements documents, as well as on the design choice. The end of this phase is achieved when all the scope is implemented, requirements are met and the outcome corresponds to the design choice.

Finally, when the implementation phase has been completed, project moves into the *follow-up* phase. During this phase, it is necessary to decide upon the project completion. Depending on the nature of the project outcome, the project may continue in this phase with activities, such as instructions, training, maintenance, writing project reports, and warranty responsibilities.

As a rule of thumb, project phases are sequential, but in some situations, they can overlap [PMI, 2013]. In case of sequential phases, one phase can start only when the previous phase had finished. This sequence decreases the uncertainty, but also decreases chances of an early project completion. Alternatively, the overlapping phases allow the project to be completed earlier, as a result of parallel work. In this case, one phase may begin before other phases are completed. Since the work is done in parallel, it might be the case that the project requires more resources, and this might increase the risks and the chances of a rework. This occurs especially when the new information comes from a precedent phase after the subsequent phase has started.

## 2.4 Project Manager

According to PMI [2013] the project manager is defined as the person assigned by the performing organization to lead the team that is responsible for achieving the project objectives. Choosing the project manager is one of the most difficult decisions, made by the senior management of any company. The chosen person is the key figure in the project team, and he or she has a linking role between the project team and the senior management. In addition, depending on the project nature and organizational structure of the company, the project manager can also be in collaboration with employees with different roles, such as business analysts, quality assurance managers and experts.

It is impossible to achieve effective project management without a professional project manager. The key responsibilities of a project manager according to PMI [2013] are to satisfy the tasks needs, team needs, individual needs. In addition, Zarenkov [2010] provides a more elaborated list of project manager's responsibilities:

- Creating the project team and organizing its workload.
- Achieving the project scope in the given timeframe with the available resources.
- Decision making in the conditions of a high level of uncertainty.
- Schedule planning.
- Interaction with project stakeholders and other managers of the company.
- Ensuring that the needed work is performed.
- Controlling the costs.

## 2.5 Coping with the Triple Constraint

Throughout the life cycle of the project, the project manager must consider and balance three often competing limitations – scope, time and cost [Schwalbe, 2011]. These three goals are also known as the *Triple Constraint*. The Triple Constraint includes the following:

- Scope. Within the scope, the project manager defines what work will be performed as a part of the project and what result, service or product does the customer expect from the project.
- Time. When dealing with the time related to the project, the project manager should decide, how long the project would last, define project schedule, specify how the team will track the actual project schedule, and decide who can change the schedule.
- Cost. The cost includes the budget used to complete the project, activities for tracking the cost, and people who can make changes to the budget.

A visual representation of the Triple Constraint and its effect on the project is illustrated in Figure 2. Each constraint has a target at the beginning of the project, but project rarely finishes according to the defined target goals because of uncertainty and limited resources.

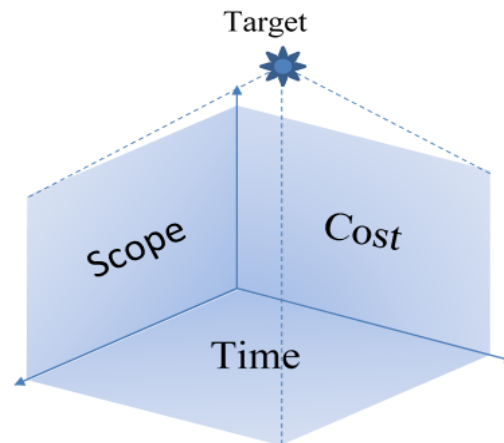


Figure 2. The Triple Constraint of project.

Dealing with the Triple Constraint means making trade-offs between the scope, time and cost for the project. For example, it might be the case that the project manager would need to increase the budget in order to meet the scope and time goals. Similarly, the project manager might need to decrease the scope to meet the cost and the time goals. Project manager is the person responsible for collaborating with appropriate stakeholders, in order to make a decision on which goal is the most important. Thus, depending on which constraint is the most important, it will be needed to adjust the other two constraints to meet the first one.

According to Schwalbe [2011], apart from the Triple Constraint, there is also the Quadruple Constraint. The Quadruple Constraint also includes, in addition to the basic elements (scope, cost, time), the quality or customer satisfaction. The fact that quality is not mentioned in the Triple Constraint does not mean it is ignored in project management. In fact, the quality is considered an inalienable part of scope, time and cost goals. A project may fail even if the scope, time and cost goals are met, but the customer is not happy with the project result, service and/or product. This might be the case, when, according to the customer, the quality is unacceptable. For the purpose of avoiding such failures, the project manager must take responsibility for a constant communication with the customer. The main outcome of this communication should be a list of determined, agreed upon and recorded requirements. This list should be checked and revised with the customer, as often as possible.

## 2.6 Project Management Knowledge Areas

During each of the project phases, there are processes to follow which are grouped into project management knowledge areas. According to PMI [2013], a knowledge area in project management is a set of defined concepts, terms and activities that are used in most projects most of the time. They are also the key knowledge areas that a project manager needs to master, in order to be able to successfully carry out the project. According to PMI [2013], there are 10 knowledge areas in project management, although some of them are out of the scope of this thesis. The knowledge areas considered in the thesis are the scope management, time management, cost management, quality management, risk management, change management.

### 2.6.1 Scope Management

According to PMI [2013], the project scope is the work to be performed to deliver a product, service, or result. Project scope management, in turn, includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully. The following is the list of project scope management processes and a brief description of each.

**Plan Scope Management.** This process is having as a result a plan, in which is stated how a project scope is defined, validated and controlled. This plan is created as a result of project meetings, attended by the project managers, sponsors, selected team members, among others.

**Collect Requirements.** This process includes the work for determining, documenting and managing the needs of stakeholders and their requirements. Requirements include the features and/or functions that are to be met by the project outcome. In addition, they include the expectations of the project stakeholders, sponsors or customer. The project success depends to a great extent on the quality of requirements management, which in turn, depends on the level of involvement of the stakeholders.

**Define Scope.** The result of Define Scope process is a detailed description of the project requirements. The description also defines which requirements will be included in the project and which not, and specifies the outcome of the project, which in fact is the project scope.

The project scope includes the following: product scope description as the outcome characteristics, acceptance criteria as a group of conditions that must be met in order to deliverables be accepted, deliverable as outcomes of a phase or project (document and reports), project exclusion as items that are to be excluded from project scope, constraints as predefined internal or external restrictions that affect the execution of the project, and assumptions as factors that are initially true without proof, and their impact on the project.

**Create WBS (Work Breakdown Structure).** The process of a hierarchical decomposition of the deliverables and work into smaller components is performed to make the overall project more manageable. The work defined at lowest level of WBS is called *work package*. Work packages are the actual tasks distributed within the team members or sub-teams.

**Validate Scope.** The project scope is validated using various inspection activities, such as validation, measuring, and examination of requirements, scope management plan, deliverables, and work performance data. After the validation work is completed, the related documents are signed by the customer or sponsor.

**Control Scope.** The scope is controlled using activities that involves controlling and managing the project scope and scope baseline changes. Additionally, control scope deals with scope creep, which is an uncontrolled project extension, including no time, cost and/or resource regulation.

## 2.6.2 Time Management

The project time management includes processes which ensure the timely completion of the project or separate phases of the project [Zarenkov, 2010]. Quite often, it is difficult to complete the project in the established period of time. This might happen in cases when e.g., the project scope is not well defined, and in consequence, the team members do not properly understand what they are working on. In addition, there might be situations, which lead to discrepancies in the planned schedule, e.g., weather conditions, delays in material supplies, the lack of reserved time to eliminate the problem. The main factors that lead to time loss are mistakes made at the time between the definition and development phases, unsatisfactory quality management, the lack of plan for unforeseen impacts of external factors, inadequate distribution of risk handling tasks between team members, and not well-established communication system, among others.

Time management can be facilitated if the project is a typical repetitive one. For this kind of projects, the experience gained in the previous ones can be applied to the future projects, but considering the uniqueness of each one. For proper time management, PMI [2013] introduces several processes that are described below.

**Plan Schedule Management.** This is the process of creating a schedule management plan, by conducting meetings between project team members, using judgment based upon expertise in knowledge area of the project. In addition, different analytical techniques can be used, such as scheduling tools, methodologies and techniques, and estimating approaches.

**Define Activities.** This process consists in defining and documenting lists of activities, activity attributes and milestones, that will be used to create the project deliverables. List of activities includes all activities required to successfully complete the project. It defines a unique identifier, a well-defined work description, and a unique title for each activity. The list of milestones is similar to the list of activities, with some differences: milestone has the zero duration, because it is a moment in time.

**Sequence Activities.** The Sequence Activities process includes the work intended to create a project schedule network diagram, which constitutes logical relationships between project activities that are represented as nodes in the diagram. A representation of a project schedule diagram is given in Figure 3, where A, B, C, D, E, F, G and H are the activities.

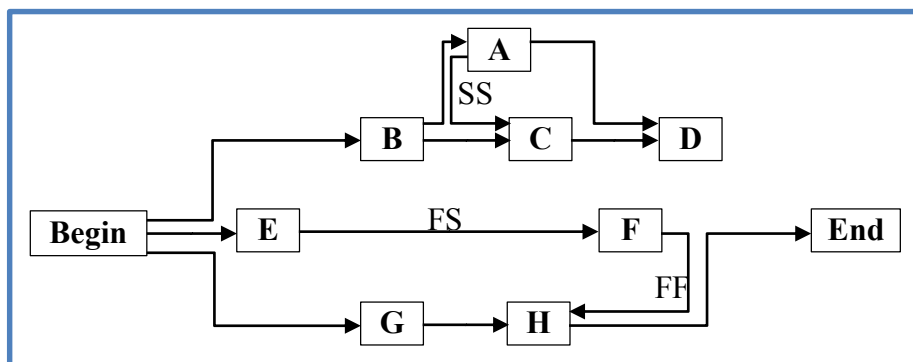


Figure 3. Project Schedule Network Diagram [PMKC, 2014].

The most used technique to create the project schedule network diagram is called Precedence Diagramming Method (PDM). PDM introduce four types of logical relationships between activities, depending upon the sequence of activities: finish-to-start (FS) is the most commonly used type of relationship, in which the successor activity will start only when the predecessor will be completed. Finish-to-finish (FF) is the relationship type, where a successor will be completed only after the predecessor has completed. Start-to-start (SS) is the type of relationship, for which the successor activity start only after the predecessor has started. Finally, start-to-finish (SF) is the relationship type, for which the successor activity will finish only after the predecessor will start.

**Estimate Activity Resources.** This process consists in estimating the types and quantities of materials, human resources, equipment, needed to complete each activity. The results of this process are various project components, concerning activity resource requirements, which defines the type and quantity needed for each activity. Another output from this process is the resource breakdown structure, which represents the resources by their type and category in a hierarchical structure. In addition, there are several project components that may be updated, such as a list of activities and activity attributes.

**Estimate Activity Duration.** This is the process which estimates the number of time periods required to finish each activity, having in consideration the estimated resources. The result of Estimate Activity Duration process are the quantitative assessments of the possible number of time periods required to finish each activity. These assessments are obtained by using the expert judgment, based on historical information from previous projects.

A similar technique to expert judgement is analogous estimating, where data from the previous similar projects is used to predict the duration. In addition to historical approaches, there are also team-based approaches to estimate activity durations. Namely, brainstorming is a beneficial techniques for the team members, as their dedication for the project increases.

**Develop Schedule.** This process is one of the most complex, yet important processes within a project. The results of this process are the following project components. First of all, schedule baseline, which is a project schedule plan, approved by stakeholders and used as a basis for comparison with the actual schedule. Second, project schedule in form of a Gantt chart, milestone chart, project schedule network diagram. Third, schedule data, which is a set of information, having as a purpose the schedule description and control. It includes, usually, such data as schedule activities and milestones, and activity attributes. Fourth, project calendars, which show the working days or working part of days available for completing the activities.

In addition, there are project documentations that may be updated as a result of Develop Schedule process, as certain parts project management plan, activity resource requirements, and activity attributes. In order to create the mentioned process outputs, various techniques are used. For example, the Critical Path Method is used to estimate the shortest possible project duration with the longest sequence of activities.



Figure 4 displays the activities network of the project and its critical path. In this example the project has 11 activities with FS logical relationships between them. Each number next to the node shows the estimated duration of the activity. The critical path in this sequence is shown in red colour. As it can be seen, the critical path has 6 activities and 22 time duration periods, which makes it the longest in sequence and shortest in duration path.

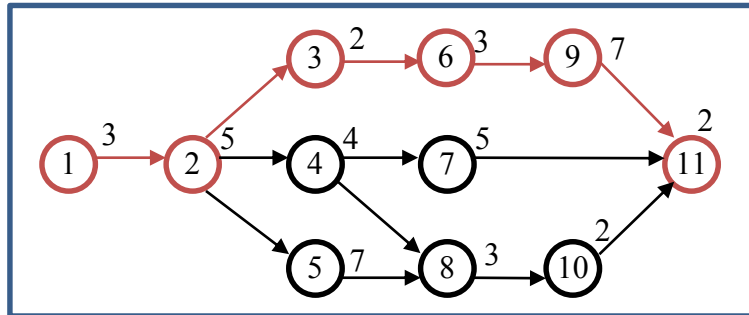


Figure 4. Project network with critical path equal to 22 time periods.

Another method used in Develop Schedule process is the Critical Chain Method. The Critical Chain Method is based on Critical Path Method and it is similar to it. However, it has a difference that consists in considering the resources availability for each activity rather than the durations [PMKC, 2014]. Same example used to show the Critical Path is used to show the Critical Chain in Figures 5 and 6. In this example each activity is given a certain amount of available resource units, considering 6 as the maximum for each period.

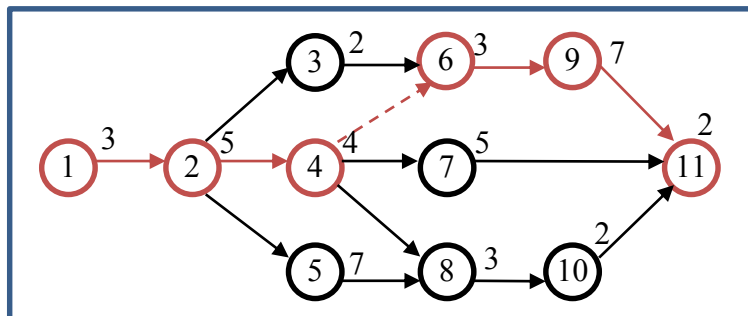


Figure 5. Project network with critical chain equal to 24 time periods.

As it can be seen from Figure 6, there is a resource conflict between time periods 8 and 13, where the resources used by activities 3, 4, 5, 6, 7 exceeds the limit of 6 resource units. In order to resolve this conflict, activities should be shifted forward, to engage the free resources between time periods 17 and 20. The way these activities are shifted depends on scheduling objectives.

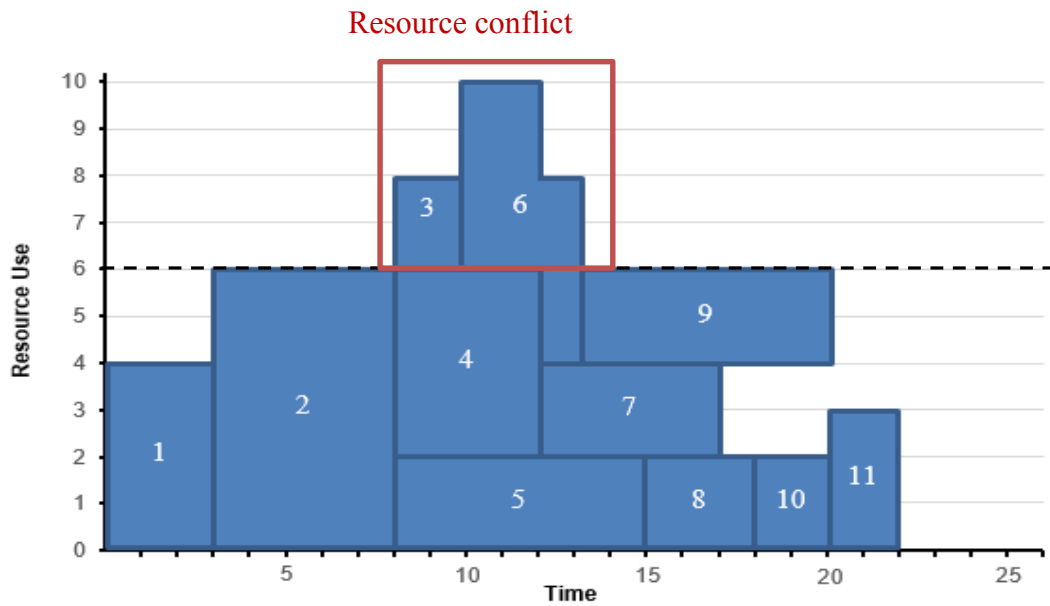


Figure 6. Resource profiles for the critical path schedule.

The result of this restructuring is shown in Figure 7, which illustrates that the project minimal duration now is 24 time periods. In addition, the project network has to be changed accordingly, namely, one link should be added between activities 4 and 6, which makes them to be executed in sequence and not in parallel. Comparing these two project networks a conclusion can be made. Namely, if a project has limitations in resources, most probably the project manager will have to make trade-offs between them and time. This fact brings us back to the Triple Constraint and its principles.

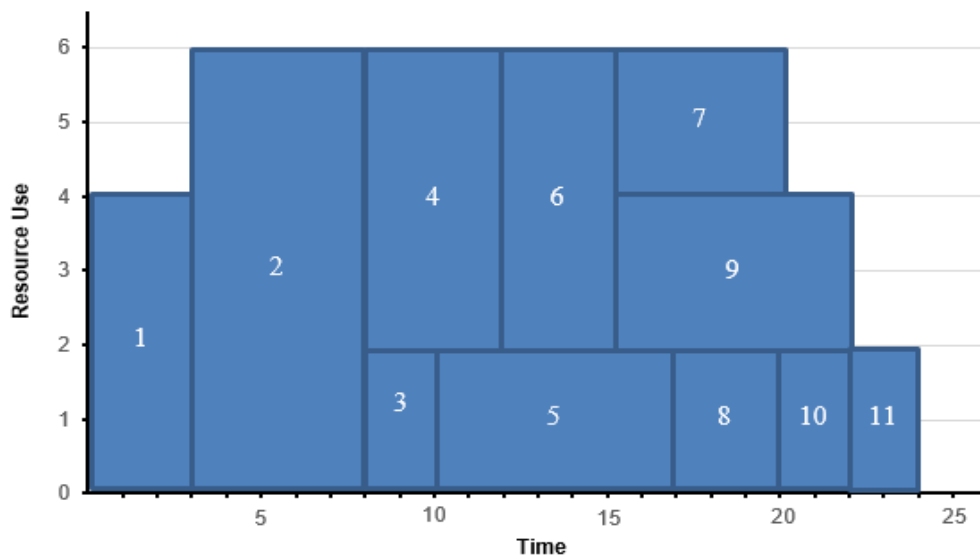


Figure 7. Resource profiles for critical chain schedule.

One of the earliest and still used tool in project schedule organization is the Gantt chart [Schwalbe, 2011]. The chart was developed by Henry Gantt in 1917 for scheduling work in shipbuilding projects and was also used for military projects in World War I for early work planning and reviewing. The Gantt chart is a special list of all the project activities, which shows their starting and ending dates in a calendar format. Currently, the chart is still a primary tool to represent planning information.

Figure 8 shows the Gantt chart in Microsoft Project 2013, where at the top is a time-scale indicating the weeks and days (1), and a list of tasks and their description (2) are displayed on the left. The schedule of each task is represented by a horizontal line (3), which starts on starting date of a task and ends on finish date of a task. The vertical line (4) represents the current date, and (5) displays the resource used for the specific tasks (e.g., Management, Project Management) and the sequence of each task. The chart also shows the milestones (6).

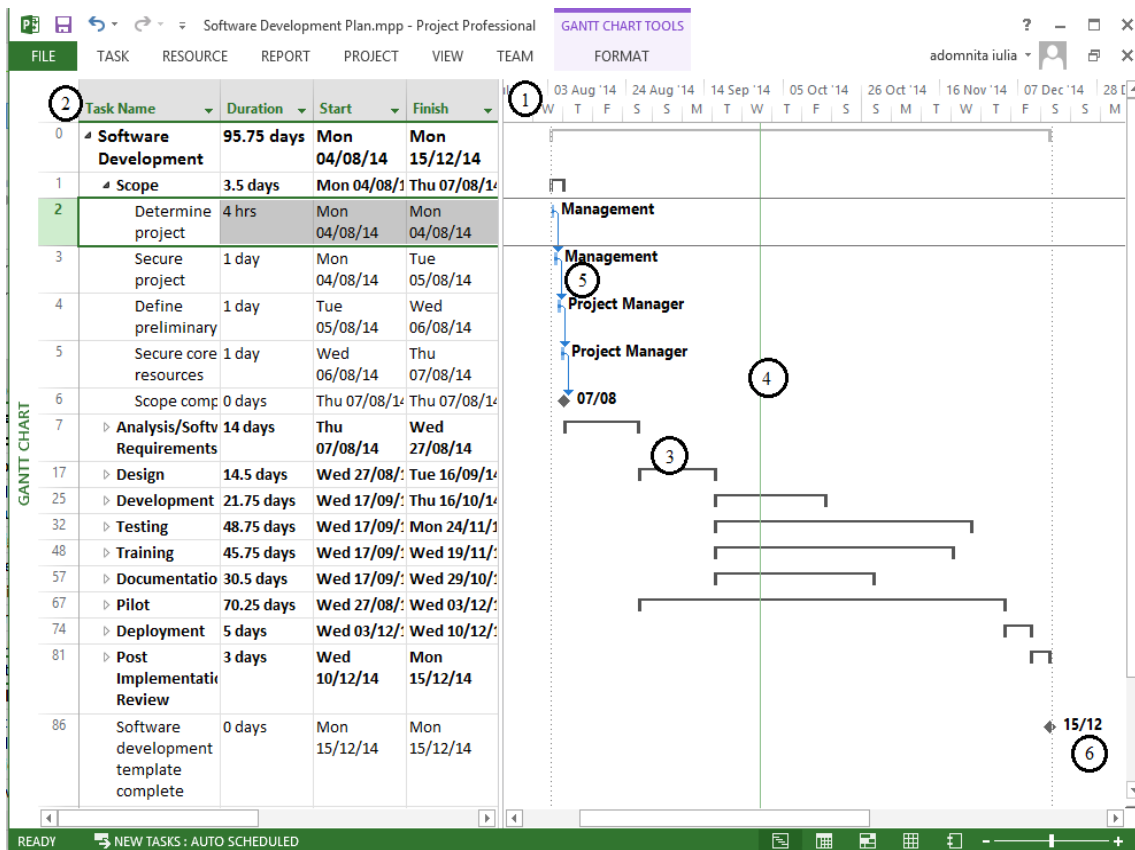


Figure 8. Sample Gantt chart created with Microsoft Project 2013.

**Control Schedule.** Control Schedule process consists in controlling the actual performance of each project activity and updating the project progress and changes to the schedule baseline. In order to keep track of each activity and have the up-to-date information about them, various techniques are used. An example of such a technique is the Performance Review, which analyse the actual starting and finishing dates, percentage of completion and the duration of the remaining work.

As the second example of a technique for controlling the schedule, project management software can be mentioned. In addition to various features it may have, most project management software include a scheduling feature that provides the ability to compare the planned and actual dates, compare and analyse the schedule baseline with the actual progress, make forecasts based on the effects of changes to the project schedule.

### **2.6.3 Cost Management**

Cost management includes processes of planning, creating, controlling, estimating the budget of the project. These processes should be executed in strong connection with the stakeholders, considering their view about the project costs. In addition, the project cost is tightly linked with the project lifetime, thus, the team members should organize the work in such a way that both these components will be minimized. There are four main Project Cost Management processes that should be executed during the project management:

**Plan Cost Management.** At the stage of planning the cost management, the project team should choose the project strategic funding options (e.g., self-funding, funding with equity or debt), choose the way to finance the project resources (e.g., making, purchasing, or renting) and the financial techniques (e.g., payback period, return on investment, or discounted cash flow).

In addition, project team members, project stakeholders and anyone responsible for project costs can hold meetings to decide on the cost management plan. Additionally, the expertise judgment, based on historical information from previous similar projects may be used to plan the cost management. As a result of these techniques, the cost management plan is developed.

**Estimate Costs.** Cost Estimate is the process of defining the approximate of the total costs needed to complete the project. During the project lifecycle the cost estimations are reviewed and refined, based on the information that becomes available. Costs will be approximately calculated for all resources planned to be used to complete the project, such as human resources, materials, equipment, facilities, and services.

There are many techniques to define the cost estimates. For example, analogous cost estimating calculates the cost and budget using the actual values from previous similar projects, considering also the actual duration, scope, complexity and other values from the previous projects. This technique is usually the least costly and the least time consuming, but also the least accurate from all techniques. However, it is commonly used in the beginning of the project, when there is a limited amount of information available.

The result of Estimate Cost process includes the quantitative costs needed to complete the project, supporting details about how the cost estimate was developed, as well as documentation of all assumptions, estimate basis, all constraints, estimate ranges and confidence level of the final estimate.

**Determine Budget.** This process defines the cost baseline by summing the estimated costs of each activity and each work package. Costs estimates are summed by aggregating the cost estimates for work packages based on WBS decomposition levels, from the lowest to the highest level – the entire project. In addition, historical information about previous similar projects and/or expert judgment are used to develop mathematical models to predict the project budget.

**Control Costs.** This process deals with the project status monitoring and updating the project costs and cost baseline according to the current project status. Current project status that includes the performance and progress can be assessed using Earned Value Management technique. This technique consists in combining and analysing the project scope, schedule and resources values.

In addition to the mentioned techniques, performance reviews are also applied to control the cost status, which compare the cost performance during the project lifecycle and estimated costs required to complete the project. As a result of these techniques, information about the work performance is given to the stakeholders, change requests may be introduced, certain organizational process assets, such as corrective actions, financial databases, or causes of variance may be updated.

#### **2.6.4 Quality Management**

Project Quality Management represents the processes of ensuring that the project outcome corresponds to the customer's requirements, by determining the objectives of the project, quality policies and responsibilities of the team members. Project Quality management considers every aspect of the project management. While it applies to all the projects, without exception, the nature of the project makes the difference between the measures and techniques used in quality management for the specific project. The main Project Quality Management processes are the following.

**Plan Quality Management.** While performing this process, team members should identify the quality requirements of the project, decide, document and agree with the customer how the project will prove the fact that it meets the requirements and what measurements shall be used to control the quality requirements.

Various techniques can be used to plan the quality management. For example, the cost-benefit analysis can be done to compare the cost and the expected benefit of the quality step. Benchmarking can also be used for planning quality management, particularly, by comparing the practices of the current project to those of a similar one, to identify the best of them and find the improvement ideas. The project team shall also consider the factors that may affect certain components of the project outcome or the development work.

**Perform Quality Assurance.** This process involves various inspection techniques applied on the quality requirements and the measurements from the quality control, to ensure that the output of the completed work and work in progress meets the specified quality requirements. Inspection may include quality audits, which is a technique to identify if the project development work is done according to the agreed policies and standards.

Other inspection techniques of the quality requirements includes such techniques as affinity diagrams, process decision program charts, tree diagrams and others. As a result, change requests and updates to the project documents and/or to the organizational process assets may be done.

**Control Quality.** Within this process, the results of quality activities are monitored, documented and further evaluated in order to have a view of the project performance and generate ideas for the needed changes. Seven Basic Quality Tools, Statistical Sampling and Inspections are the methodologies used to control the quality.

As a result of this process, the quality control measurements, validated changes, verified deliverables, performance information, change requests, updates to the project documentation and organizational process assets will be available for the project team for further project management and development.

### **2.6.5 Risk Management**

Project risk management represents the processes of management planning, identification, analysis, response planning, and controlling the risks in a project. A project risk is defined as an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as, scope, schedule and quality [PMI, 2013].

Various types of project risks can be defined, based on different factors. Considering the perception factor, project risks can be defined as known and unknown. The known project risk is a risk, which has been identified, analysed and responses have been planned.

Another factor is the risk target, which defines project risks as individual, i.e. have impact on particular parts of the project, and overall, i.e. have impact on the project as a whole. By the character of the risk impact, it can be positive or negative, also known as opportunity and threat. Similarly, risks can be divided by the project team reaction on them in excludable, preventable and compensated risks.

Alternatively, risks can be divided by their source, as follows: time risks, cost risks, quality risks, and scope risks. Time risks are the ones that will hinder the project to be completed on time. In the worst case, delays in project development will have negative impact on timely project deliverables, and as a consequence, on customer's satisfaction.

Cost risks are the ones where the costs will exceed the funds, or where the cost price will exceed the sale price. Quality risks are the ones, that the quality of work done, materials and/or project output will be low. Finally, scope risks are the risks in which the main objective of the project will not be achieved or in which the project scope will not be completely implemented. The main processes involved in risk management are the following.

**Plan Risk Management.** This process includes activities for defining how the risk management will be conducted. For this purpose, various techniques are used, such as analytical techniques, which are aimed to give an understanding of the overall context of the risk management in a particular project. Expert judgment is used to ensure that the risk management plan is established in a comprehensive manner. Furthermore, project team members hold meetings to develop the risk management plan.

Usually the risk management plan includes such components as the methodology used to perform the risk management plan, the roles and responsibilities of the team members assigned to perform the needed risk management activities, the budget needed to fund the assigned resources, the schedule for risk management activities, the risk categories used to help the team members to identify the sources of potential risks, definition of risk probability and impact, along with a probability and impact matrix, stakeholders' tolerances for each potential risk, the reporting formats to define how the process will be documented and tracking the risk management process.

**Identify Risks.** Identifying the risks is an iterative process of determining which risks may affect the project development or project outcome. Each risk statement shall be clearly defined and provide the ability to compare the effect of different risks on the project. In order to identify as many risks as possible, the following techniques are used. For example, all available documentation is reviewed and analysed to find potential risks.

Other examples used to identify the risks are, the information gathering techniques, such as brainstorming, Delphi technique, interviewing, root cause analysis. In addition, analysis techniques, like assumption, diagramming, SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis are performed to examine the project. After some or all the mentioned techniques are carried out, the risk register is created. Risk register contains the list of identified risks described in a detailed and structured form, and if possible, the list of potential responses to a risk.

**Perform Qualitative Risk Analysis.** This process involves the prioritization of the risks based on their impact and probability. For this purpose, an assessment of the likelihood that a risk will occur and the risk impact on each project objectives (scope, cost, time and quality) is performed.

Other assessments, such as risk data quality, that evaluates the usefulness of the information about the risk for the risk management and risk urgency, may be conducted. Furthermore, expert judgment and risk categorization may be considered for the qualitative risk analysis.

**Perform Quantitative Risk Analysis.** Quantitative analysis focuses on numerical information about the risk impact on the project objectives. Examples of techniques used to perform this process are the data gathering and representation techniques, including interviewing and probability distribution. Other used techniques are quantitative risk analysis and modelling techniques, such as sensitivity analysis, which analyse the potential impact on the project, expected monetary value analysis and model simulation.

**Plan Risk Responses.** Within this process the activities to decrease the effect of threats and increase the effect of opportunities are developed. Depending on the character of the impact, different risk response strategies may be developed. In case of threats, avoiding, transferring and mitigating strategies are applied. Avoiding is the strategy, where team members try to eliminate the threat or protect the project objectives from its effect by extending the schedule, changing the project management plan, reducing the scope, among others. Transferring is another strategy, where team members transfer responsibility for the threat, along with the ownership of the response to a third party. Mitigating strategy involves the attempts to decrease the probability or impact of a risk, by developing simpler processes, conducting more tests, choosing a more reliable supplier, among others.



In case of opportunities, exploiting, enhancing and sharing strategies are applied. Exploiting strategy requires the team members to try to realise that opportunity by assigning responsibilities to the most talented resources, using latest technologies, among other activities. Enhancing is another strategy which implies the team members to try to increase the probability and/or the impact on the project objectives by adding more resources responsible for this risk. Finally, the sharing strategy is the one where the team members transfer a part or the whole ownership of the risk to a third party.

Accepting is the common strategy for threats and opportunities, whereby the team members do not take any action towards dealing with the risk, except documenting and changing the strategy in case the risk is changing its probability and/or impact on the project objectives.

**Control Risks.** As well as identifying the risks, controlling them is also an iterative process, which includes implementation of the risk responses, tracking the identified risks and identifying new ones. Risk reassessment is a technique often used to identify new risks by reassessment the existing risks. In order to examine the effectiveness of the risk responses, risk audit techniques are often performed.

In addition to the mentioned techniques, analysis techniques, such as variance, trend, and reserve analysis are conducted, as well as technical performance measurement are performed. Variance is a technique used to compare the planned with the actual results. Trend is another analysis technique used to control the risk, considering the performance information. Finally, reserve technique is used to identify whether the remaining time and cost reserve are enough for the remaining risk items.

### **2.6.6 Change Management**

Project Change Management are the processes, which provide project corrections throughout the project lifecycle, needed when internal and/or external environments are affecting the project objectives [Zarenkov, 2010].

Changes that may happen in the project can be divided in controlled and uncontrolled changes. Controlled changes are the ones that can be directly influenced by the project manager. For these changes, the project manager can perform corrective actions on the changes themselves or on their source.

Uncontrolled changes, in their turn, are out of project manager's responsibility scope. In this case, the project manager can only reduce the occurrence probability and negative impact on project objectives. Depending on the change source and predictability, changes can be predictable (the occurrence probability is known a priori) or unpredictable (the occurrence is unknown in advance).

When managing the project changes, it is important to consider the priority of their solutions. For this reason, very important changes require instant solutions and require including all the necessary resources. Important changes require urgent solution and require including all available resources. Minor changes require a solution that will be performed using the available resources and without any impact on other project work. Nonessential changes do not require any intervention.

Each change request shall be either approved or rejected by a responsible person, identified in the project documentation. A Change Control Board may be created if needed, to review, evaluate, delay, approve or reject, as well as communicate and record decisions made about each change request. Change requests that have been approved may require adjustments in the cost estimates, activities, schedules, resources, among others.

A change can be requested by any stakeholder, either verbally or in a written form. However, each change request should be documented in the change log, according to the agreed format. The change log shall include at least the information about the change impact on the project objectives and it shall be accessible for the appropriate stakeholders.

### 3. Project Management Tools

Managing and controlling the schedule, costs, resources, budget, among other activities done by the project manager, require special skills from him or her. Those skills include the abilities to create, manage, summarise and interpret the large scales of numerical data. In order to produce and process large amount of various information, the project manager uses various software systems and tools. Nowadays, many software products, are available to help the project manager to perform complex and time-consuming calculations. Using this kind of software, enables the project manager to focus more on decision making, develop more effective alternative management and implementation approaches, among others.

Another advantage of using project management software systems and/or tools is the ability to share the information with a dispersed team. This features helps in improving the productivity and effectiveness of project implementation, only if the project manager is well trained and experienced in using the tools, as well as in computer data processing. The novel features of collecting and processing the data provides a better control and estimation of costs, time and quality during the project management life cycle.

Project management systems (PMS) are the comprehensive software products, used for processes and project management functions automation. Most PMSs have the following similar features: planning and controlling, project calendar, reporting, analysis of alternatives. For a better perception of the variety of PMSs, Zarenkov [2010] introduces a classification of PMSs based on which, the following categorization can be proposed:

*Simple PMS (SPMS)* are the PMSs designed for managing only one project. They are simple to use and the generated information is easy to perceive. SPMS have limited features for data analysis and they do not allow complex relationships between project activities (e.g. Excel),

*Complex PMSs (CPMS)* are the PMSs used as well for one project, although they provide features for project planning, monitoring and reporting. CPMSs allow the real-time project complex analysis and project plan reviewing, based on the actual project data. Examples of CPMS: Microsoft Project, Basecamp, Jira by Atlassian.

*Professional PMSs* are the PMSs intended for multi-project planning, monitoring and controlling by using a common open database along with a set of software products, which considers the multi-project monitoring and reporting. Examples of PPMS: Microsoft Project Professional, Primavera Project Planner for Enterprise.

Following subsections include the overview of some of the project management tools. Microsoft Project and Basecamp are chosen for the review as the two most used project management tools according to Capterra website [Capterra, 2014]. In addition to the fact that they are most used, these software solutions provide rather different approaches in project management, which was interesting for the further analysis.

### **3.1 Microsoft Project Professional**

Microsoft Project is a professional project management software tool designed and distributed by Microsoft. It was developed to assist project managers in the various project management routines. The following overview is based on personal experience with the latest version of Microsoft Project Professional and on the information from the official Microsoft sources related to Microsoft Project and other products. The version of software at the time of writing is 2013. Despite the apparent complexity, Microsoft Project is rather simple from the concept point of view. It operates with two entities – tasks, resources and connections between them. It can be argued that in fact, Microsoft Project consists of a database, a user interface and automation means. Automation means in Microsoft Project are the processing done, according to certain algorithms, as a response to the user input.

*Tasks* in Microsoft Project are created by simply adding a new row in the task table and filling in the appropriate columns. The columns available for tasks are the task name, duration in days, starting day, finish date, predecessors, and the resource assigned to work on the task. There is also the possibility to add new columns from the list of available ones. One column worth to mention here is the predecessor. Microsoft Project provides advanced means to manage the sequence of tasks. For instance, it is possible to assign a type of the task sequence (FS, SS, FF, SF) and a value for lag. The lag, in turn, is either a positive or negative value in percentage. In addition, tasks have a constraint type, which can be selected from a predefined list and a constraint date. Examples of constraint types are the following: “as late as possible”, “as soon as possible”, “finish no earlier than”, among others.

*Resources* in Microsoft Project have a broad usage. A resource in Microsoft Project can be of one of the three different types. First type is work, which can define a person who is implementing a certain work on the project. Second type is materials, which are the resources to be consumed in developing the project. Finally, third type is the cost, which defines the costs spent on the project implementation. As well as the tasks, resources are created by adding them in the table of resources and filling the columns in with appropriate data. The available columns are the resource name, resource type, material, initials, group, and maximum units, among others. When the type of the cost is chosen, the other columns are automatically filled in or emptied, depending on the type selected.

An important fact about the resources is that, it is possible to enable it for a certain time period and assign it to a specific task. Based on this data, Microsoft Project can create various views and reports, by filtering, grouping, sorting the data, among other functions. In addition, the software can also calculate the starting and finishing dates for tasks. Calculation is done using a specific algorithm, based on the resource availability and task sequences.

Following is the overview of how various project management aspects can be handled with Microsoft Project.

**Scope management.** Microsoft Project does not provide means to plan the scope management, in the sense that it does not have straightforward solutions to manage the scope plan or any other documentation. However, it is possible to integrate the software with other tools, in order to have documents attached to the project or even tasks. Collecting the requirements, defining, validating and controlling the scope are similar issues for Microsoft Project as planning the scope management. One process within the scope management that is possible to perform with Microsoft Project is creating WBS. In this case, work packages are actually the tasks defined in the task table.

**Time management.** Time management is the strong side of Microsoft Project. It allows the user to perform all the required processes within time management knowledge area, such as defining the activities, sequencing them, and defining the resources and durations. In addition, it provides options to visualize the tasks in a Gantt Chart, calendar view, timeline view, critical path, among others.

**Cost management.** Resource entities are used in Microsoft Project to manage the costs. As well as the time management, Microsoft Project can handle all needed processes within the cost management. For instance, it is possible to estimate the costs, determine the budget and control costs. Moreover, it is also possible to export the cost data to Microsoft Excel to have an in-depth data analysis by using the Excel PivotTables, charts, and other functionalities [Microsoft, 2014b].

**Quality management.** Microsoft Project does not include any feature to manage the quality of the project outcome, except creating specific tasks to perform the quality assurance, or other quality related activities timely.

**Risk management.** No specific means for risk management are included in Microsoft Project, although Microsoft provides guidelines on how to identify and manage the risks using the existing features. It is also mentioned, that third-party add-ons, exporting the project data to Microsoft Excel and using their functionality is a common practice to identify and analyse the project risks [Microsoft, 2014a].

**Change management.** Change management has to be done manually or using other software tools. In any case, Microsoft provides guidelines on what data from Microsoft Project should be taken into account when managing the change requests and how the analysis on the change impact could be done [Suchan, 2014].

**Documentation management.** In order to manage the project related documentation, SharePoint should be integrated with Microsoft Project or Microsoft Project Server should be used instead of Microsoft Project. However, the latter one has a different purpose than project management.

**Communication means.** SharePoint and Lync can be used along with Microsoft Project in order to have the ability to contact the project stakeholders directly from the project [Microsoft, 2014c].

### **3.2 Basecamp**

Basecamp is a web-based project management collaboration and task software, developed by Basecamp Company formerly known as 37signals [Basecamp, 2014]. Basecamp was initially developed as an internal tool to manage small sized projects, with about 3-4 people. As the time passed, more and more features were added, starting with file storing on the servers of the company and ending with applications for mobile operating systems.

This overview is based on the guidelines and other resources available on the official website. The project in Basecamp is similar by its structure to a blog or a closed social media. It contains the same entities and principles as a social network. Namely, it is based on communication between the team members and other stakeholders, sharing files and creating events (tasks or to-do lists). As the main entities, it contains personal account, users, comments, attachments, events, among others. In addition, it is also available for the most commonly used mobile operating systems.

When starting a project with Basecamp, the project manager has to create an account. From that moment on, the project manager is also the account owner and the administrator of that account. He or she can then invite other team members and stakeholders and assign the administrator rights also to some of them. Account owner and administrators can delete users later on, although all the content related to them will still be available in the account.

Next step is the actual creation of the project. Project in Basecamp is a workspace where discussions happen, files are shared and to-do lists are managed. In addition, Basecamp also contains a calendar, where all the deadlines, single-day and multiple-days events, or events at a certain time are shown. A project can be created from a previously created template or a blank project. Further on, the team members are added from the available users and the client access can be enabled. The client access is a special user mode, where the user is enabled to see only items that were not restricted.

It is worth mentioning here that for each project management task, there is a number of official and third-party applications that can bring more functionality to the default one. Basecamp provides a list of these applications grouped by their purposes. At the time of writing, there are 23 mobile and desktop applications for viewing the to-do lists, generating business dashboards, generating printable weekly reports, among others. For time tracking, invoicing and accounting there are 19 applications. In order to create reports, charts and plans, Basecamp provides a list of 32 different applications. In case the team is dealing with a big number of documents, they can select certain applications out of 5 for file backup and synchronization. In addition, there are 5 applications for contract and proposal generating, building and signing. In case the project type is software development, the team may need certain applications for bug tracking, source control, subversioning, or others. For these kind of projects, Basecamp gives a list of 13 applications that would meet the requirements of the team and project. There are also 10 applications for marketing, design and asset. Furthermore, the customer service and support tasks can be completed with certain applications out of 5 from the list. Following is the overview of the features that Basecamp provides for the most common project management knowledge areas. It also should be taken into account the fact that for most project management processes, a third-party application can be found.

**Scope management.** Processes related to the scope management can be performed in a dedicated discussion thread. In addition, users can attach documents or other files to the discussion, e.g., the scope management plan or the requirements document.

**Time management.** Basecamp uses calendars to help the project manager and the team members to be up to date about the upcoming deadlines, events and other dates. There are two types of calendars – project and stand-alone. Project calendars are the ones which contain the dates related to the project. Stand-alone calendars, in turn, are the ones where the user can store any dates that do not belong to the project, but still important, such as birthdays, holidays, and days off.

Furthermore, both types of calendars can be shared between team members and the project manager. More than that, Basecamp allows creating recurring events, synchronizing with Outlook Calendar or Google Calendar, and generating email notifications for the whole team.

In this way, developing and controlling the schedule, as well as defining and sequencing the activities can be done in project calendars. Third-party applications can also be found for these tasks, yet no application was found for critical chain and critical path analysis.

**Cost management.** Basecamp does not provide any cost management means out of the box. However, third-party applications can be used to determine the budget, estimate and control the costs.

**Quality management.** Quality assurance and controlling quality can be performed only with Basecamp functionality. For this purpose, dedicated discussions with the customers can be created, and certain quality related documents can be shared with them for collaboration.

**Risk management.** Basecamp does not include any automation means for risk management, neither do any of the listed third-party applications. However, storing and sharing risk related documents within Basecamp can come in handy when dealing with risks.

**Change management.** As well as performing quality management, changes can be requested and managed by creating dedicated discussions. However, there are no capabilities within Basecamp, neither within third-party applications to analyse the impact of changes on the project.

**Documentation management.** As it was already mentioned, storing the documents was one of the first functions Basecamp could provide. Later on, other features related to files were added, as attaching files to the comments in discussions or to-do items, and changing the privacy settings.

**Communication means.** Basecamp is all based on communication, and discussions are at the core of this project management tool. Discussions are created as stand-alone, or every time when a to-do list or an event is created, or when a file is attached to the project. Discussions can also be shared with the customer if needed, and archived when they are of no more use. There might be also cases when the project related communication is held through emails. For these cases, Basecamp has an Email-in feature to forward emails to the workspace in Basecamp.



## 4. Metadata

With the rapidly increasing amount of digital data and of information technologies, it is important to be able to store, access, manage and share information between computer systems. The mentioned functionalities would be impossible without explicitly describing the properties of that data. The descriptive data plays an important role for the software that performs the mentioned functions, as well as for the users that create queries, analyse and interpret the data. That kind of descriptive data is called metadata and it is a special type of information resource. The creation of metadata may be time- and resource-consuming, but it provides a wider range of usage opportunities.

### 4.1 Defining Metadata

Metadata is used in various knowledge areas and intellectual communities, thus, the definition of it depends on the context it is used for [NISO, 2001]. In addition, the type of metadata and the type of data it describes, also influence on how metadata is defined. Following are most used and commonly known metadata definitions:

1. Metadata is data about data [NISO, 2001], [Gill et. al., 2008]. This definition is a standard laconic one. The interpretation of metadata with this statement is often related to a library card catalogue. However, this definition can be referred to, if only the described data (library catalogue) is an electronic source. This is so because, in fact, a physical library catalogue and books are not the actual data, they are “containers” for data.
2. Metadata is a structural description of the essential attributes of an information object [Gill et. al., 2008]. This definition was proposed to address another shortcoming of the first definition. Namely, the first definition does not reflect the nature of metadata. Basically, all metadata, by its nature, is a structured information about the properties of the described object. These properties can be, for example, the title, author, and date of creation.
3. Metadata is structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage an information resource [NISO, 2001]. As well as the second definition, this one addresses the structural nature of metadata. In addition, this definition is more constructive, as it also reflects some of the functions of metadata.

As it was already mentioned, nowadays metadata is extensively used in substantially different subject domains, and it is a multidisciplinary topic research with different emphases from different academic communities. Consequently, metadata definitions are not limited to the proposed ones. In other words, each knowledge area, such as statistics, geospatial analytics, astronomy, medical sciences, and web technologies, among others, can define metadata in their own manner.

## 4.2 Metadata Categories

Different approaches are applied to categorize metadata. Such approaches include categorization by metadata functions, by features, according to the type of data it describes, by the semantic abstraction levels, and by the knowledge area application among others.

Nonetheless, the most used classifications are the functional aggregated ones. Mainly, the classification proposed by NISO [2001] is one of the most referred to. It was proposed to classify the metadata into descriptive, structured and administrative types of metadata. Administrative metadata, in turn, is divided into two subtypes – rights management and preservation metadata. Below is the categorization along with a brief description of each type.

- Descriptive metadata describes the content of the resource, bibliographic data for publications, annotation, identifiers (e.g. Uniform Resource Identifier, Digital Object Identifier), and author, among others. The purpose of this type of metadata is primarily discovery and identification.
- Structural metadata characterizes the overall structure of the resource and its components, and amount of information units, among others.
- Administrative metadata includes the resource creation and update dates, information about who created and modified, ownership data, user access permissions, information about the versions and/or resource copies, where are they stored, and other information required to manage the resource.

This type has two essential metadata subtypes:

- Rights management metadata, concerned with the management of intellectual property rights.
- Preservation metadata, which describes the various aspects of resource preservation.

A more elaborate classification has been found [Gill et. al., 2008]. This classification redefines to a certain extent the above classification, as well as introduces two more metadata types and omits one type. Below is the categorization with the definitions for the types that are introduced for the first time.

- Descriptive metadata.
- Administrative metadata.
- Preservation metadata.
- Technical metadata includes description about system functioning, documentation about hardware and software, technical information about the performed digitization, authentication data and provided information security (passwords and encryption keys, among others).
- Use metadata describes the nature and level of resource use, including the use of resource copies and different versions, and authorship rights, among others.

### 4.3 Metadata Principles

A concrete set of metadata functions, elements, features, content and other aspects depend on the features of the system which uses them, on the nature of resource described by metadata, and on user requirement, among others. However, there are common principles which are recommended to follow in any domain of metadata [Duval et. al., 2002], regardless of the metadata scheme aspects or application.

**Modularity.** Metadata Modularity is one of the main principles of building a metadata scheme. It is an invaluable principle, when it comes to a system with a variety of source content formats, approaches to content management, and styles of resource description. The idea behind this principle is that the metadata scheme must be designed in such a way that it will enable the metadata designers to reuse metadata modules, learn, and apply the best practices. As a result, metadata designers can take advantage of the suitable existing metadata blocks, rather than reinventing blocks anew.

**Extensibility.** Most metadata schemes have common elements, such as the creator or the creation date. In the same way, most metadata schemes have various additional elements, specific for the knowledge area or domain. This fact requires the metadata architecture to enable the metadata to accommodate for the given application. On one hand, the application might require additional elements. On another hand, some of the existing elements might not be useful. Therefore, the metadata schema must allow both the addition and ignorance of metadata elements.

**Refinement.** Any metadata schema has a level of detail, which depends on the user requirements, domain application and even costs available. Thus, the metadata designer must decide the suitable detail degree for the metadata system. The right level of detail can be achieved by applying two notions.

The first notion is the refining by adding more properties, attributes, and qualifiers, among others, to metadata elements. The addition must be done cautiously, with sufficient degree of detail, but not more, as relatively high costs are involved. The second notion is the use of predefined value sets for properties, attributes, and qualifiers, among others. In addition, common value sets increases the semantic interoperability of the system.

**Multilingualism.** Considering the present tendency of internationalization, metadata systems must as well take into account the cultural and linguistic diversity. Multilingualism is achieved by creating “neutral” schemas (internationalization) or adapt the “neutral” schema to a local context (localization). Apart from this, it is important to include in the metadata schema description of cultural aspects of the resource. In addition, it is a recommended practice to create the metadata elements as culturally neutral as possible. Nonetheless, there are challenges to reach the multilingualism. For example, in some cases, it can be important that the metadata is following the local conventions for specific applications and/or communities. Another challenge is that the architecture of a global metadata might not be able to provide equal functionality.

#### 4.4 Metadata Functions

Metadata accomplishes various functions in the systems they are used in. Their specific functions and contents depend significantly on the information technologies, on which the system is based, on the functionality of the system, on the properties of the information resources, on the way the resources are organized, and on the nature of the resource processing tasks, among others. Following are the description of the main metadata functions. The examples of metadata representing options mentioned below are universal, i.e. are not specific to any knowledge area or to any particular professional community.

**Resource discovery.** Resource discovery is one of the most important metadata functions which provides the metadata usage as search criteria. For this purpose, not only identification metadata is used, but also other types of metadata, such as full text indexes in text searching systems. Discovery of the required information resource can be performed also by catalogue browsing, navigation through subject indexes, and categories, among others. However, using semantic metadata in discovery process allows to significantly reduce the level of data noise.

**Data validation.** Metadata of structured data (database schema) allows controlling the data format, data type, verify compliance with integrity constraints. These tasks are performed by Database Management System (DBMS) engines.

**Electronic resource organization.** Organization of electronic resources is a set of tasks aimed to provide an effective preservation and processing of the information resources, as well as the access to them. In this way, the metadata which represents a database schema, provides the required information about the database organization, data integrity constraints and access control to the database engine.

**Digital identification.** Metadata defines what elements or attributes related to resource instances provide the resource identification. An example of these kinds of elements and attributes are primary and secondary keys in database tables. Their values identify unique rows or certain row sets. Another example is the identifiers used in electronic text catalogues, which are often generated by the system. These identifiers serve as links to the documents stored in the system and are not explicitly available for the users. For the purpose of text document identification, sets of descriptor values or key words are used.

**Providing interoperability and reuse of information resources.** Interoperability is the property of systems that have different interfaces, hardware, software, data structures to exchange data with minimal loss of information and functionality. On the basis of interoperability, the information resources can be reused by standardizing the metadata representation using open standards. For instance, the database, schema of which is defined in a descriptive sublanguage of Structured Query Language (SQL) or in an Object Definition Language (ODL) of the Object Data Management Group (ODMG) standard, can be reused in another DBMS, which supports the SQL standard or ODMG respectively.

**Defining the access restrictions and providing the information security.** Metadata provide the means to define the access restrictions and user permissions to access the information resources or to perform certain operations within the system. These permissions and restrictions are verified by the system engines, when the user tries to perform the protected operation. Digital signatures, security certifications, open and closed keys, message, user and other authentication means represent metadata aimed to provide the information security.

## 5. M-Files Technologies

This chapter discusses the M-Files metadata based solutions. It begins with a general introduction on technology itself and the root principle of the product. Further, the metadata usage is described in a top-down manner. In addition, the compliance with previously discussed metadata principles, functions and categories is presented. Finally, this chapter describes a project management customer case study with previous M-Files solution, its challenges and limitations.

### 5.1 General Information

M-Files is an enterprise information management solutions (EIM) developed by M-Files Corporation., formerly known as Motive Systems [M-Files, 2014a]. The information given in the thesis is based on the latest official public version of M-Files at the time of writing, which is 10.2.3920.54. Currently, the available products are M-Files Document Management System, M-Files Quality Management System, and M-Files Enterprise Asset Management [M-Files, 2014b].

M-Files products are available for Windows-based operating systems, although most of the functionalities are also available through web and mobile interfaces. In this way, M-Files products can be accessed from most operating systems, whether from a desktop or a mobile device, using M-Files Web Access or M-Files Mobile Access. Web Access is supported on the latest versions of the most used web browsers, such as Internet Explorer, Mozilla Firefox, Google Chrome, Safari and Opera [M-Files, 2014e]. Mobile Access, in turn, is available on such mobile operating systems as Android, iOS and Windows Phone.

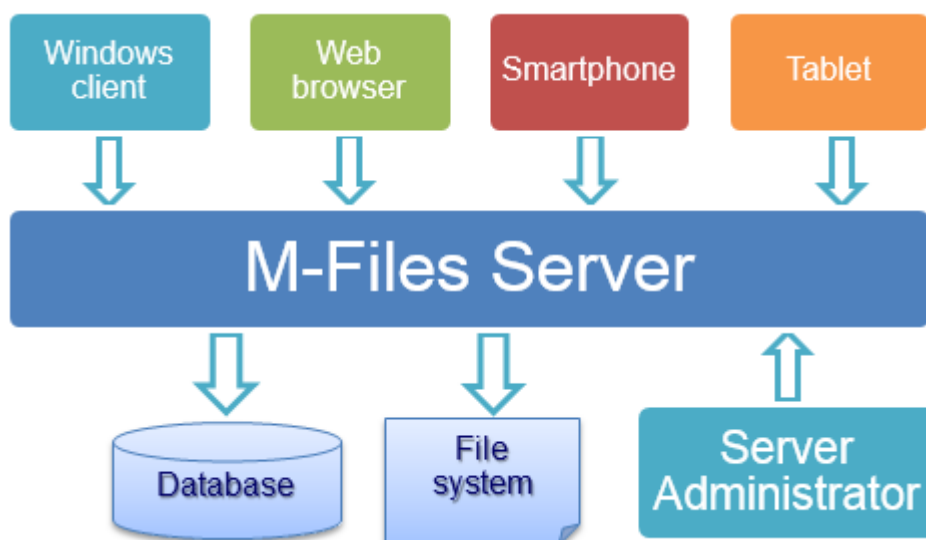


Figure 9. M-Files client-server architecture [M-Files, 2012].

M-Files is based on client-server information system architecture [M-Files, 2012]. It consists of a client application, which connects to the server through a server application hosted on the main server. The system architecture and components interaction is demonstrated in Figure 9.

**M-Files Server Administrator Application.** The M-Files Server Administrator is a Microsoft Management Console snap-in application, used to manage the M-Files Server. The application is the backbone in the interaction between the data storage and the client.

The main functions of M-Files Server Administrator are to save the objects, to manage access rights, to handle the version history of the object, to provide configuration means for connection to other systems. In other words, the application saves and manages all the data related to M-Files system. M-Files Server Administrator application can be installed on a Windows server, Windows desktop or cloud service. Due to the fact that the application is a service, it starts automatically when the server machine starts. Furthermore, the service will run, even if there are no users logged in on the server machine.

A significant advantage of the Server Administrator application is that it provides two approaches to connect to external sources. However, the connection is possible only if the external source supports OLE DB or ODBC connections. The first approach is read-only, which allows reading from the external database and saving to M-Files. The second connection is two-way, which also allows saving changes from M-Files to the external database. Furthermore, it is possible to connect to an email server. In this way, all email messages and attachments are saved to the server and can be managed as any other M-Files objects.

The Server Administrator application also handles the centralized physical storage for metadata structure, documents and other objects, called *vault*. The vault is the storage instance located on a server running M-Files Server Administrator. It is displayed on the user's machine, which is connected to the server, as a directory on his/her local computer. The M-Files Server can have multiple vaults, for different purposes, with different content.

M-Files provides solutions to automate various tasks in the vault. For this purpose, *event handlers* can be created for different operations performed on the objects. Event handlers are created within the M-Files Server Administrator Application in VBScript scripting language, using variables, and M-Files API. Examples of the use of event handlers are changing the permissions when the workflow of the object has changed, or creating a new document when a new object is created and relating the document to the object.

**M-Files Client Application.** The client application accesses the server through a Representational State Transfer Application Programming Interface (REST API) if the client uses the Mobile Access or Web Access. Otherwise, i.e. in case of the Windows client, the application can connect through TCP/IP, HTTPS, SPX-protocols or interprocess calls. For the purpose of this thesis, only the Windows client is considered and discussed.

From the user point of view, the main function of the client application is to provide a fast and easy access to the information stored in the vaults located on the M-Files Server. The application lets the user create objects, which are further indexed, saved to and versioned on the server, and made available for other connected users. In this way, the objects and their versions can be quickly searched and accessed.

The user interface of the client application is integrated directly to the Windows Explorer, so that it is easily approached by all existing Windows users. However, the user interface looks similar to the Windows interface, the functionality differs, considering the metadata, file contents and other aspects. One difference is that, when the files open, the user is prompted whether he or she wants to *check out* the file or open in *read-only* mode.

The checked out mode provides the versioning feature in M-Files. In other words, editing the files is possible only in check out mode and only for the user who checked out the files. In this way, the situation in which several users edit the same file and content loss may occur, is handled. The file is released for editing to other users when the editor *checks in* the file. In addition, checking in saves the changes and creates a new version of the file in the file version history on the server. In this way, the new version is created only when the file is modified and checked in. In contrast, the file can be modified and saved, in which case the new version will not be saved to the server and the file is not made available for editing to other users.

Considering the user interface of the client application, it can be mentioned that it consists of several panes: left pane, search bar, listing pane, and right pane. An example of a client interface is shown in Figure 10.

First, the *left pane*, known as the task pane, contains shortcuts to the most common actions, such as navigation through the vault content, manipulating or creating a new document, object or dynamic view, as well as assigning new tasks to the users. In addition, the left pane also contains specific actions for the currently selected object type. The set of shortcuts in the task pane can be customized from the server application, which will make the changes visible to all users. Another way to customize is from the user interface itself, in which case, the modifications will be available for the current user only.



Second, the *search bar* is located in the top section in the user interface. Its purpose is searching for documents and other objects stored in the vault. It can be used in simple or advanced mode. In the first case, the search is based on metadata values, file contents and object titles. In the second case, the search can be further filtered based on the object types, properties and other additional conditions.

Third, the *listing pane* is the main area of the user interface, as its purpose is to display the objects of the currently opened view. In case the object has properties that reference to other objects, they are shown as child objects for the current one. In this way, all the related objects are displayed in a tree view, which can be expanded or collapsed.

A *View* in M-Files is the alternative for folders in Windows and it is another noteworthy difference between these two user interfaces. In contrast to the Windows folders, the content of M-Files views is dynamic and it changes based on the objects metadata. Considering this property, it is clear that one object can show up in multiple views.

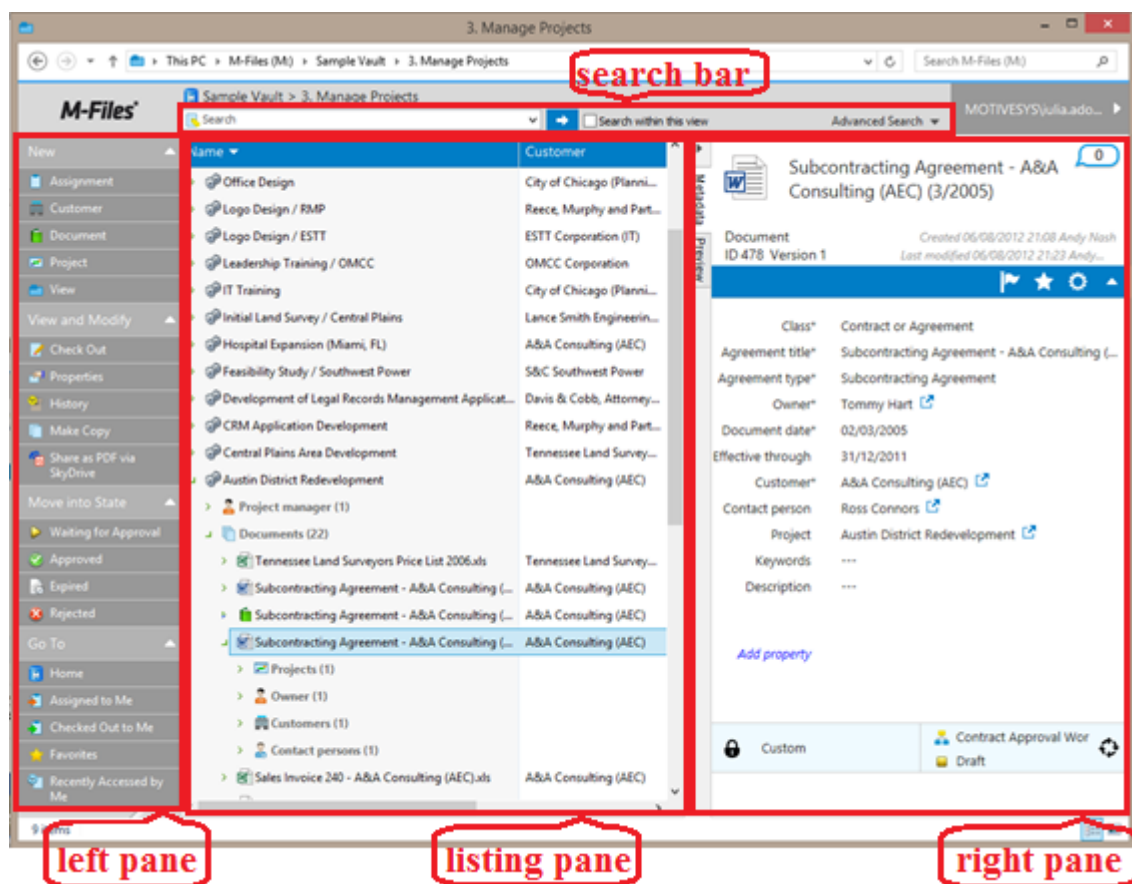


Figure 10. M-Files user interface example.

Views allow browsing through the object relationships, thus all other objects, related as child or parents to the displayed one, will be shown under the displayed object. In order to create views, the search results can be used, in which case, the filters for the view will be based on the search parameters. The other way is to create a view using the shortcut from the task pane and define the filters in the creation window. As a result, the created views can be either shared or private. Moreover, sub-views can also be defined as virtual folders. The main purpose of the virtual folders is to group and/or sort the objects defined in the parent view by their properties.

Finally, the *right pane* hosts various functionalities in separate tabs. For instance, when the current view is the home view and no object is selected, the right pane displays the options for creating new objects, along with the learning resources section. When an object is selected, regardless of the current view, the right pane displays the metadata card and the preview tab.

The metadata card visualizes the object type, when and by whom was the object created and lastly modified, properties, permissions, and workflows of the selected object. The metadata card allows the users to change the object metadata, considering the access rights. The preview tab provides quick and easy access to the content of the most commonly used file formats, such as Microsoft Word, Excel, PowerPoint, PDF, as well as AutoCAD files. The preview is enabled in case the relevant software is installed on the client machine. In addition to the mentioned features, the content of the right pane can also be customized according to individual needs.

**The M-Files User Interface Extensibility Framework.** M-Files provides for the developers specific means to develop their own applications for a required customization of M-Files Client appearance and functionality [M-Files, 2014d]. These means are namely consisting from a collection of features, APIs, program execution environments and libraries.

The M-Files applications are usually written in JavaScript and deployed as M-Files Applications in form of zip-packages. The packages can be installed on a specific vault from M-Files Server Administrator Application and executed alongside the M-Files Client Application.

The purpose of M-Files Applications is to meet a business specific area or need. As examples of what can be implemented, can be mentioned the changes in appearance of the task pane, content of the listing pane, adding tabs to the right pane with a specific information and functionality. In addition, more functionalities can be implemented to be used along with the existing ones, such as two-side integration with third-party services.

## 5.2 Metadata. The Core of M-Files

As mentioned above, the definition of metadata can be adapted according to the purpose it is used for, the system it is used in, and community it uses, among others. Considering these factors, M-Files adapted the metadata definition as the information about the document properties, such as the parties of a contract or the recipient of a letter [M-Files, 2014f].

Metadata in M-Files is the core of the whole system, which can be said to be metadata-driven. Therefore, all tasks performed in M-Files, such as saving, organizing, managing and searching for objects are based on their metadata. Thus, in addition to the content itself, all objects in M-Files also have metadata. What is more, M-Files objects do not require any files at all. In this case, the metadata is self-sufficient in terms of information.

Metadata in an M-Files vault is defined using the M-Files Server Administrator application in a hierarchical structure, which is demonstrated in Figure 11. In this way, on the highest level of metadata structure is the *object type*. The object type defines the objects that are to be stored in the vault. By default, M-Files provides document and document collections as built-in object types. Other object types, such as Project, Milestone or Vendor, can be defined based on the organization needs.

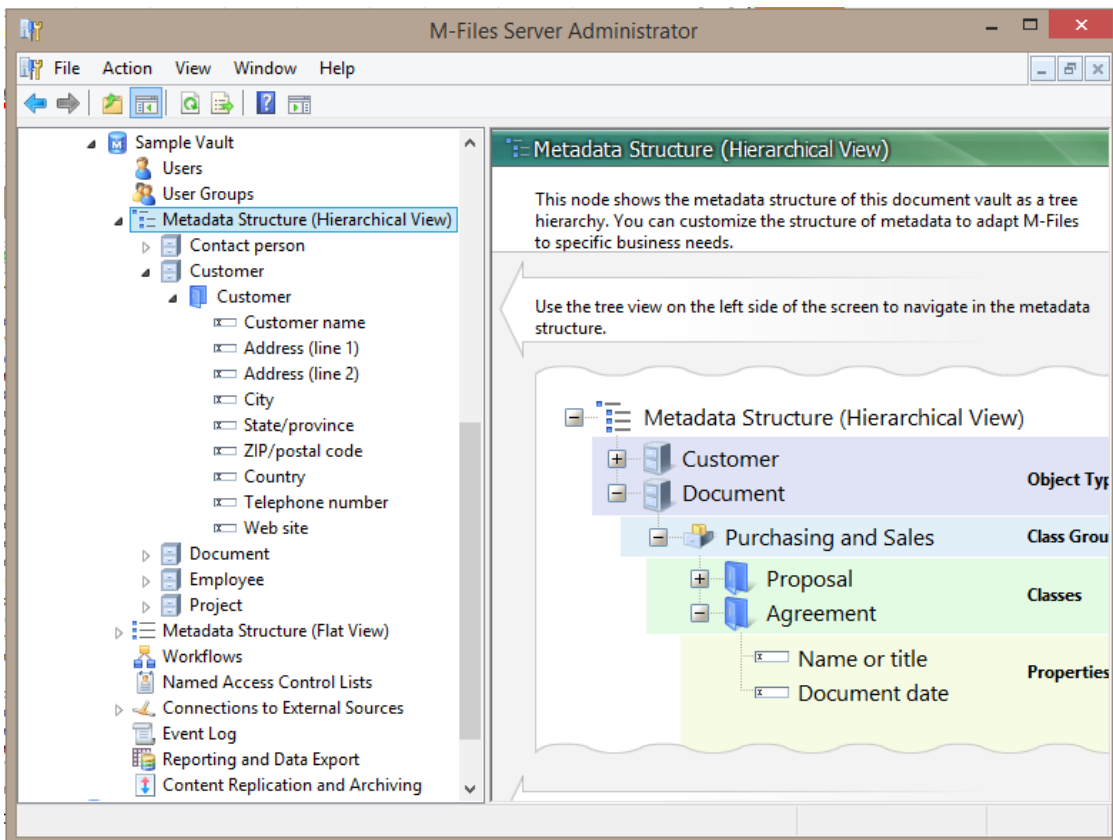


Figure 11. The hierarchical view of metadata as seen in M-Files Server Administrator application.

Based on the object types, *classes* are the instances used to further categorize the information and files according to their use. For instance, the vault can contain documents of project plan class or contract class. By default, unclassified document class and other document class, as well as assignments are built-in in M-Files. In addition, similarly to the object types, other classes can also be defined by the administrator user.

In addition to the mentioned features, classes provide another valuable feature for data management, namely *workflows*. Workflow is a type of data that enables the automating of company processes and routines. They are created individually for each organization and considering the purpose of usage. Workflows contain workflow states that define the current state of an object. Transition between the workflow states can be restricted to certain sequence of states and/or considering specific property values of the object. An example of a workflow created for document objects of Contract class, along with the available settings for one of the workflow states, is shown in Figure 12.

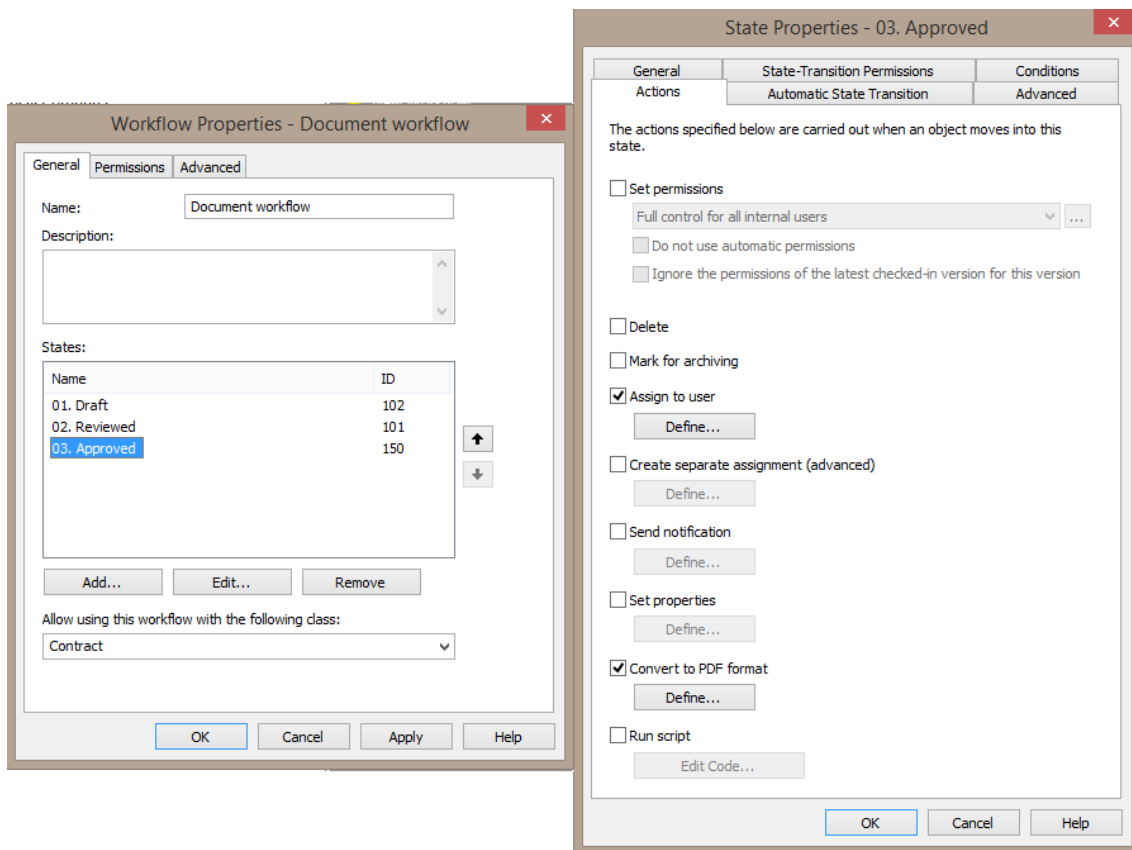


Figure 12. An example of a workflow and the available settings for one of the workflow states.

The state transition can also be done automatically, when specific conditions are fulfilled. These conditions can be for example, the time period passed since the object creation, or when a specific assignment has been marked completed. State transition also facilitate the company routines by the actions specified to be carried out when an object moves from one workflow state into another. In this cases, a different access permission can be set for the object, the object can be deleted, and a notification can be sent to a user or a user group, among other functions.

Classes in their turn, have *properties*, which are the actual metadata of the object. Properties can be either optional or required and have various data type and content. Free-form text, integer and real numbers, single and multiple object references, as well as date, time, and Boolean are data types available in M-Files.

By default, the name or title of the object is a required property for each class. In addition, there are several built-in properties, such as “Created”, “Created by”, “Is template”, and “Keywords”. Property values can also be automatically created, by simple concatenation of other properties, simple or customized numbering, or can be calculated using VBScript. What is more, in case the property data type is an object reference, the values can also be filtered based on the property values of the referred object.

Above all, M-Files also provides means for property value validation. This is useful in case, the values of the property must meet a specific criteria, e.g. the length of text must be not more than 100 symbols or the date must not be later than the current date.

*Value list*, as well as object type, is also a high-level instance in M-Files metadata structure. Value list is a type of data that contains a set of predefined values. The value lists are created by the system administrator in such a way that they meet the organization needs and system architecture. Value lists can used for property values, in case the data type of the property is object reference.

Using the predefined list of values, makes the M-Files to be in compliance with the Refinement principle of metadata. In this way, value list increases the semantic interoperability of the system and provides a fast way to specify the metadata of the object. In many cases, proving values for a property from a predefined set is more practical than specifying it manually, e.g. setting a city or a time unit. On the other hand, it is unreasonable to use value list for such properties as a description or a total sum.

M-Files also provides an advanced feature for *access permissions*. Within this feature, it is possible to define specific permissions for user and/or user groups for performing various actions on objects. The system administrator can define different permission rules for each object in the vault. These rules include permissions to read, edit, delete and change permission and can be assigned to an individual user or to user groups.

As permissions can become complex, they can be grouped in Named Access Control lists. These special lists can be reused, thus facilitating the system administrative work. The fact that the access permissions, as well as value lists, object types, classes and properties can be fully customized, make the system to be in compliance with the Extensibility and Modularity principles of metadata.

In addition to means for storing and managing data in M-Files, it is also possible to analyse the data and create various reports. *M-Files Reporting* is represented by a multicomponent reporting module. This module is based on data extraction and processing outside M-Files Server.

The data extraction is possible by means of M-Files Reporting Data Services within M-Files server. Thus, the administrator must specify the set of data to be extracted and must run the extraction either manually or according to a specific schedule. Further, the data is sent to a database and processed by Microsoft SQL Server Reporting Services infrastructure.

The reporting service is responsible for report rendering and displaying, so it should be properly deployed and configured. The reports are then displayed in the Client application. There, the report represents a graphical object that makes the data analysis quick and easy.

### **5.3 Project Management with Previous M-Files Solution. Gasum Case Study**

As it was discussed earlier, project management is a complex all-embracing process. It requires special skills from the project manager, it consists of various activities, and different aspects must be considered. This is why well-organized project management requires advanced scheduling, planning, communicating, as well as analytical, and other tools. These tools, if well adopted, can bring significant productivity in project management process and can give many advantages, when it comes to document management.

Having in consideration all the mentioned features and customization possibilities in M-Files, it can be argued, that it provides powerful, easy to learn and use means for business processes. What is more, based on a company internal analysis of the products deployment, it was found out that M-Files common use case is more than document management [Javanainen, 2014]. Due to the metadata-based architecture used at the core of M-Files, enterprises can manage any other information objects that are essential for their business, such as projects, activities, tasks, employees, and customers, among others.

A good example of how a company is taking the full advantage of metadata capabilities for project management is Gasum. Gasum is the largest provider of natural gas in Finland. The company has a vast amount and variety of work to manage, such as importing gas to Finland and further distributing it to homes, industries, energy producers, as well as producing compressed natural gas and biogas. Consequently, the amount of information, processes and internal documentation, as well as files and records generated by their business partners, is substantial.

The details of M-Files implementation for Gasum are unfortunately not available for public access. However, certain analysis can be done based on the case study and background information about project management and M-Files technologies.

Initially, Gasum was combining internal network drives and SharePoint to manage the business documentation [M-Files, 2014c]. But with the growth of the company, the documents and their versions were multiplying exponentially. In these circumstances, the staff faced the issues of finding the required document to be either too time-consuming or not possible at all.

Other issues used to arise, when the documents were eventually located. In these cases, their version could be not the correct one, which led to quality control issues and challenges. At that point, Gasum started to look for document management solutions, which would address their issues and challenges. After evaluating quite a few document management systems, in 2010 Gasum chose to deploy M-Files solution.

Considering the M-Files functionality for document management, it can be argued, that at this point all the documentation is stored in a dedicated vault. In this condition, the latest or required version of any document has to be available in that vault, regardless of the view it is accessed from. In addition, searching for the document has to be much faster now, if the appropriate metadata is set for it and used as a search criteria.

As an essential requirement for Gasum was the M-Files integration with Microsoft SharePoint. SharePoint is still widely used as workspace tool for the company and communication channel. SharePoint workspaces of Gasum dynamically pull the objects and documents from M-Files, based on metadata rules. The retrieved content is displayed then in the right context: by project, process, meeting, and business area, among others.

What is more, due to the metadata usage, the same document can be shown in different contexts if it is relevant to them. For example, in order to give the ability to discuss on certain content related to a meeting, meeting agendas are stored in M-Files and also integrated in SharePoint, where discussion can happen.

Since Gasum deployed M-Files as their document management system, the company is taking advantage of the Windows-based interface. More than that, it is also using it as the "superior document management system with robust workflow capabilities and the ability to easily integrate with our CRM and ERP systems", according to Tiina Niinimäki, Development Manager at Gasum.

To summarize the case study, it should be noted, that currently Gasum is using the previous M-Files product which is a more general and not specifically created for project management. Nonetheless, they achieved more productivity in project management than they used to have with other project management tools.

However, the currently used M-Files system is lacking most of the analytical tools required in the project management routines. By also adopting those, it can be expected that the efficiency of project management and implementation would increase significantly. This can be assumed due to the automation that would be provided with the additional tools.



## **6. A New M-Files Project Management System**

In order to improve the project management capabilities with M-Files, it was decided to implement a new dedicated M-Files product, which will incorporate most of the lacking features an advanced project management tool has. The system was implemented as an internal M-Files project as a concept at first and continued to be developed and deployed to customers as a fully functional system.

In this chapter, the system scope, implementation, comparison to other project management tools is done and findings are discussed. At first, an overview of the project is made, where the system architecture and scope are defined and implementation aspects are considered. The functionalities, which were planned and further implemented or rejected, are mentioned along with the reasons for implementation and rejection. After that, a quality comparison analysis is presented between the new M-Files Project Management (MFPM) system and the other discussed project management software. Finally, the findings are discussed, based on an interview conducted with a Senior Manager at M-Files Corporation.

### **6.1 System Overview**

As it was mentioned, M-Files provides solutions for project management, but in a limited capacity, comparing to other dedicated project management tools. However, the need in project management functionality integrated in M-Files is high in demand. Thus, in result of several meetings with certain managers and directors within the company, it was decided to continue the building of a metadata-driven project management dedicated system. As a result of those meetings the system metadata architecture was discussed and the scope for system functionality was defined.

#### **6.1.1 Metadata Structure**

The metadata architecture of the system was developed before the beginning of this thesis, although certain changes were done also as a part of the thesis project. The metadata structure is presented in a hierarchical way. At the top level the object types, workflows and value lists are defined. At the lower level the classes, workflow states and value list items are defined accordingly. Finally, the properties are defined for the classes at the lowest level of the metadata structure hierarchy. The available object types include various built-in and custom types.

There are several object types which have the same name as the class it is using. Instances of such object types and classes are the following: “Report”, “Project”, “Phase”, “Activity”, “Milestone”, “Employee”, “Resource Allocation”, “Portfolio”, “Project Expense”, “Project Risk”, “Role”, “Hour Logging Event”, “Invoice”, and “Change Request”. Examples of other created classes and their object types are “Assignment” of “Issue” object type, “Unclassified Document”, “Other Document”, “Contract”, “Project Documentation”, and “Project Plan” classes of “Document” object type, “Recurring Activity” and “Recurring Event” of “Recurring Item” object type, and “Customer” and “Supplier” classes of “Organization” object type.

Each class has its own set of property definitions, however, many particular properties are used for multiple classes. In this way, the system has a list of reusable built-in and custom property definitions, which includes such properties as “Start Date (planned)”, “End Date (planned)”, “Start Date (actual)”, “End Date (actual)”, “Progress (%)”, “Duration (days)”, “Schedule Status”, “Issue Status”, “Description”, “Budget”, “Logged Work (h)”, “Risk Price”, “Risk Impact”, “Risk Probability”, as well as references to other objects, as “Activity”, “Invoice”, and “Contract”.

The created set of workflows consists of such items as “Document Workflow” with “Draft”, “Reviewed”, and “Approved” workflow states, “Project Workflow” with “Proposed”, “Initiated”, “Schedule Planning Complete”, “Resource Planning Complete”, “Ongoing”, “Complete”, and “Rejected” workflow states, “Milestone Workflow” with “New” and “Passed” workflow states, “Change Request Workflow” with “New”, “Under Analysis”, “Analysed”, “Rejected”, “Accepted”, “Planned”, and “Implemented” workflow states.

The set of value lists includes various sets of predefined items, which would fulfil the project management needs. For instance, the system includes value lists for months, time units, countries, statuses, expense types (equipment, service value list items), and risk types (funding, resources, schedule, scope value list items). Value lists are typically used as object properties, value of which is of a certain reference type.

### **6.1.2 Scope and Implementation**

The scope is consisting of two parts – high priority features and features to be developed in perspective. High priority features are those which have the key importance in any project management that is to be carried out using the developed system. Features for future development are those, which was decided that project management can be carried out without, or using other tools.

All discussed features were recorded in a scope document. The scope document was revised a number of times during the project development lifecycle. After each revision decisions were made regarding leaving out or including in the scope certain features. The system was decided to be implemented as an M-Files vault. In addition to the metadata structure, it was decided to implement custom features, as various event handlers, M-Files Applications and reports.

By the end of the scope management, the following list of features was included.

**Project Dashboard.** Project Dashboard is one of the implemented features. Namely, it is an M-Files Reporting module, intended to give a quick glance at the most essential information about the project. The Project Dashboard for a “Kitchen Renovation” project is shown in Figure 13. By default, the data for the first found project is displayed, but the project can be changed from a drop-down menu. As far as the project is selected and “Update Report” button is clicked, the data in the user interface is updated according to the selected project.

The report contains several sections, such as Project Overview, Project Health, Monthly Expenses Overview, Monthly Effort Overview, Milestone Status, Risk Overview and Critical Risks. First section, Project Overview, contains the basic data about the project, e.g., planned start and end dates, actual start and end dates, names of the project manager and customer, as well as the completion percentage.

Next section, Project Health contains the current status of the project schedule, project profitability and work effort. For an easier perception, statuses are represented by colour indicators. Thus, in case the project is on time or ahead of schedule, the indicator for project schedule status will show a green light, otherwise, the light will be red.

Project profitability behaves in a similar way, with a specific difference. In other words, the indicator light will be green in case the project has a positive profit, red – in case the profit is negative and yellow – in case the project profitability is zero. The light for the last indicator is this section, i.e. work effort status displays in the same way as the light for the project profitability. In this way, if the effort has a positive value, then the light is green, for a zero value the light will be yellow and red for a negative value.

Monthly Expenses Overview is a chart, the data for which is fetched from all expense objects related to the selected project. The data is then grouped by expense type (e.g., Services or Equipment) and month. The maximum value of the vertical axis corresponds to the project budget. Similarly, the horizontal axis depends on the months for which the expenses were defined. The information about the total expenses for the project is displayed below the chart.

Monthly Effort Overview, is a chart similar to Monthly Expenses Overview. The data for this chart is fetched from the logged hours related to the selected project. The data is then grouped by month for which it was recorded. The maximum value of the vertical axis corresponds to the value of total planned work for the selected project. The horizontal axis, in turn, corresponds to the months the working hours were logged in for. The data about the total working hours is shown below the chart.

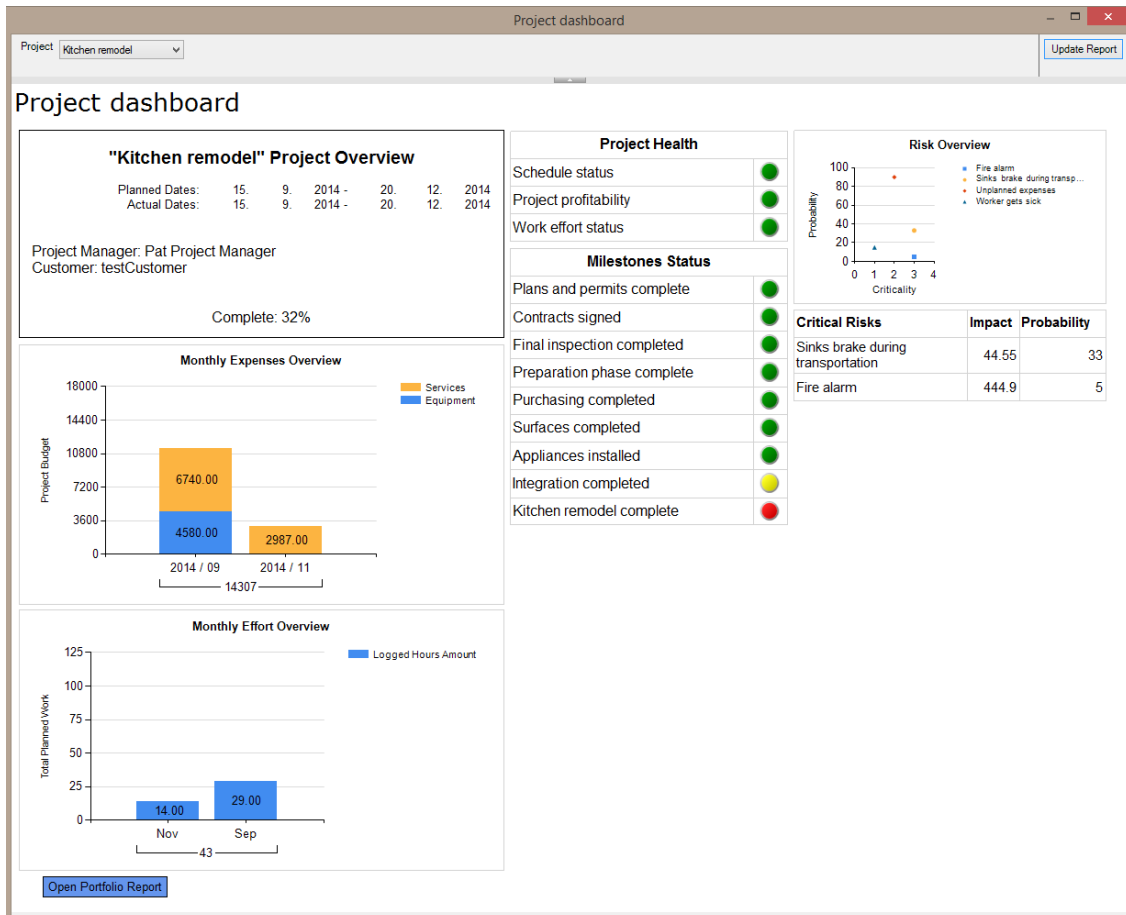


Figure 13. Example of the Project Dashboard for a kitchen remodelling project.

Milestone Status is a table with all the milestone objects related to the selected project and their current status. The status of a milestone is represented in a similar way as the Project Health statuses, i.e. with colour indicators.

In case of milestones, the indicator shows a green light if the difference between the planned and actual date is zero. The values for the yellow and red indicators can vary, depending on the project requirements. For instance, the yellow colour can indicate that the difference in planned and actual date for the milestone is between one and 5 days. The red colour can indicate that the difference is more than 5 days.

Risk Overview is a risk matrix, the data for which is retrieved from the risk objects related to the chosen project. The risks are placed on the matrix, according to their probability and criticality. Probability has the role of the vertical axis with the maximum value of 100. Criticality acts in the role of the horizontal axis, which has 4 as the maximum value in the user interface. But, in fact, there are only three available values to choose from in the vault. Risk section includes also the table with specific risks. It is the table that shows all risk objects that are critical for the current project. The table displays the title, impact and probability of each risk.

**Portfolio Report.** As well as the project dashboard, portfolio report is an implemented feature. Namely, it is a part of the M-Files Reporting module, intended to present the overall status for the available projects. The application lets the user to select a project workflow state and by clicking the “Update Report”, the corresponding data will be displayed. An example of a report is shown in Figure 14.

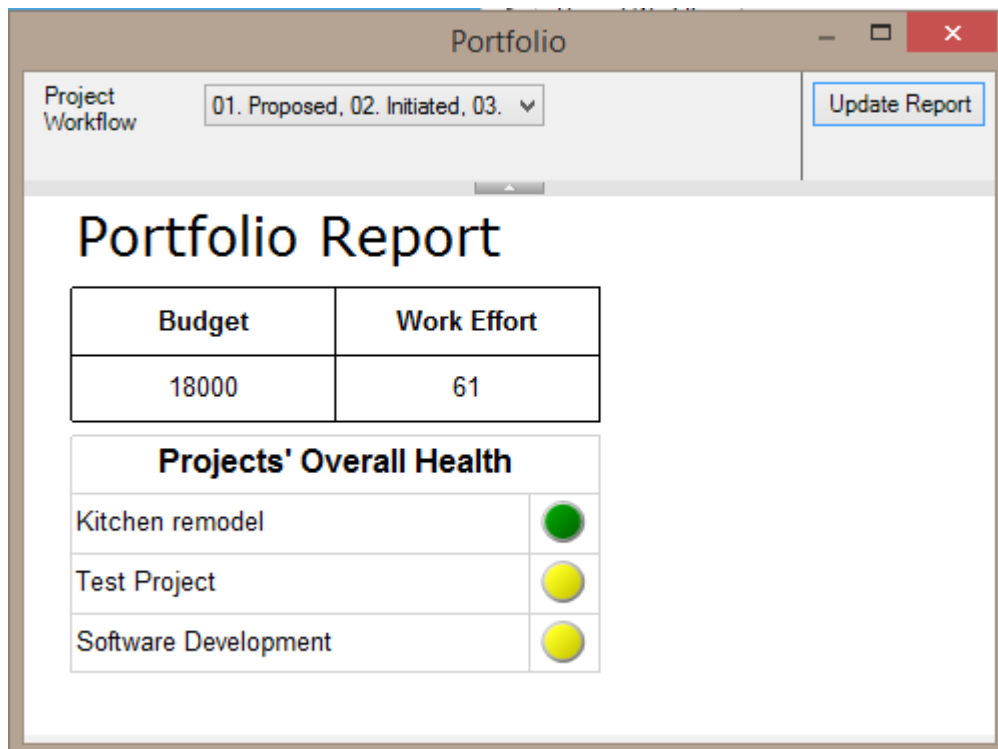


Figure 14. Example of a Portfolio report.

Portfolio Report contains the Projects' Overall Health. It is a list, which is filled in with title of the projects the workflow status of which corresponds to the selected one. Next to the title of the project, a colour indicator is shown. The colour of the indicator depends on the average status values for each project. In addition, above the Projects' Overall Health is shown the overall for budget and work effort calculated based on the projects selected.

**Gantt Chart.** Gantt chart is an M-Files Application included in the list of implemented features. As it can be seen from the Figure 15, it is a typical Gantt chart, where the progresses of the project, phase and activity are displayed using horizontal bars. The bars begin at the actual starting date and ends at the actual ending day defined in objects. The chart also allows the user to display other objects as well, with the condition if the object has at least one property with date as data type. In order to demonstrate this, project documentation and milestones were also defined to be displayed in the chart. Moreover, other objects can also be defined, but they will only be displayed in the left side list and not on the chart itself. In case the object has a predecessor, the chart can be customized in the way that it will also show the link between the connected objects.

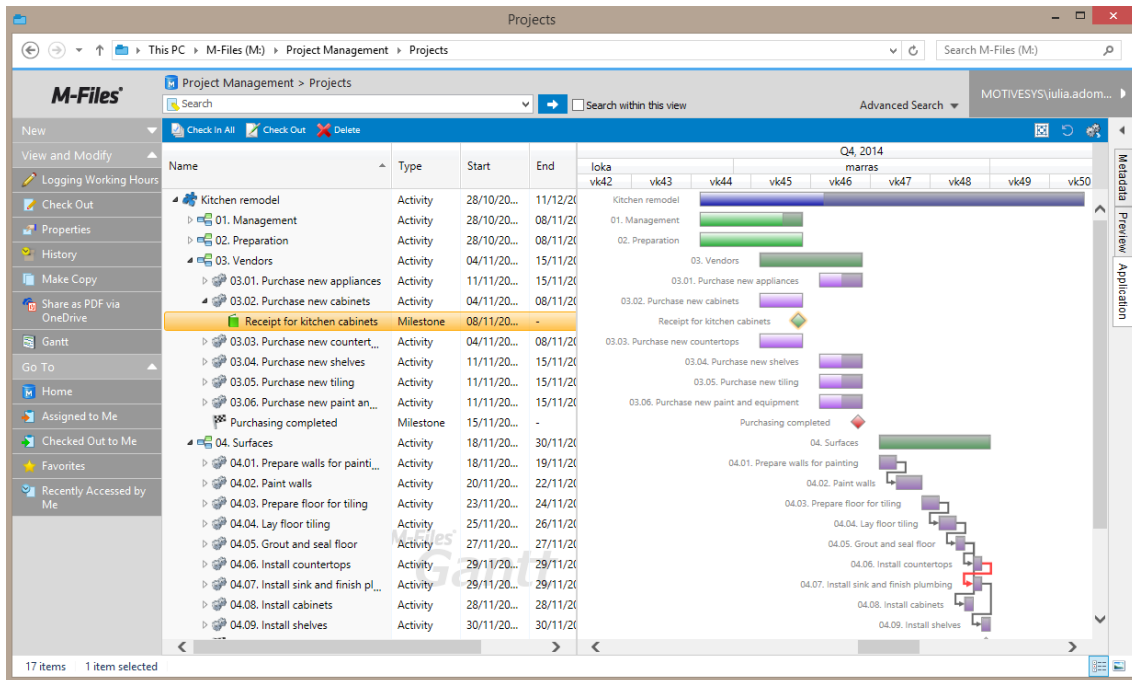


Figure 15. The Gantt Chart for a kitchen remodelling project.

**Importing from Microsoft Project.** As Microsoft Project is a widely used project management tool, it was decided to implement an M-Files Application that will import data from projects created with Microsoft Project to MFPM. The application is rather simple and it has minimum functionality. As a result, it allows the user to select an xml-file exported from Microsoft Project and by clicking the “Import button”, it will retrieve all possible data and create the appropriate objects in MFPM.

Due to the different concepts in how and what data is created and managed in Microsoft Project and MFPM, it was impossible to implement the importing of all the data. Alternatively, the user (i.e. the project manager) has to create certain objects manually, in case they were available in Microsoft Project and not imported to MFPM.

**Project Baseline.** During one of the meetings regarding the MFPM implementation, it was decided to develop an extension as an M-Files Application that will make a “snapshot” of the project and all related objects. The purpose of this feature is that the project manager can use the snapshot for analysis. For instance, there are always change requests from different stakeholders. So, in order to have a concrete image of how the Triple Constraint or other aspects of the project are affected, the project manager can apply the change, i.e. add a new activity, a new phase, or change the cost and/or time, among others.

As a result, he or she can verify how other aspects are changed. For this, the project manager can use any of the already existing extensions – Gantt Chart, Portfolio Report, Project Dashboard, or by simply browsing the project hierarchy and analysing the appropriate objects and their properties.

**Change Request.** Change request functionality is crucial in any project management system. Therefore, it was included in the list of features to be implemented. Change request is implemented as an M-Files Application, the user interface of which is shown in Figure 16.

Figure 16. User interface for creating a new or updating an existing change request object.

The created or updated change request will be related to the selected baseline. The application allows the user to select a project baseline from a corresponding drop-down list. In order to update an existing change request, the user shall select it from the “Select the change request or create a new one” drop-down list. Similarly, to create a new change request, the “New Change Request” value from the same drop-down list shall be selected.

Further, the user shall select the type of object that shall be changed (e.g. activity, phase, milestone, project expense). Depending on the type of object selected, a drop-down list will be filled in with objects available for the project. A specific object from that list shall be selected in case the change requests an existing object to be changed. Otherwise, i.e. the change requests a new object to be created, the first value in the list shall be selected.

After the type and object is defined, the project manager changes the properties of the object, according to the change request. The change of properties is done in the user interface, where the appropriate properties are enabled to edit, depending on the object type selected. In case an existing object is selected, the property values are filled in by default with values from the selected object. Otherwise, the value is left empty if the property is not a required one. In case the property is required, then its value is filled in with a certain default name or current date, depending on the data type of the property.

**Logging Working Hours.** Ensuring that the needed work is performed is an essential task of the project manager. Having this in mind, it was decided to include in the project scope an M-Files Application for visualizing and recording the working hours for employees. The application is presented in Figure 17. The employee for which the hours are outputted is selected from a drop-down list. For a better user experience, the list of logged working hours is grouped by year and month, and no more than 12 months are displayed at once. The month and year for which the hours should be inputted can be selected from drop-down lists. The list of logged hours in the main user interface are then updated accordingly.

When a month is selected, its content is expanded and the user can record the working hours. The required information for logging the working hours is the date, when the work was performed, the project for which it was performed, activity and hours done, as well as the description of the work. The team member can edit or delete the recently logged hours and add more work. The system administrator has more rights in this case. He or she can manage also the previously logged working hours for any employee, i.e. add, delete and edit the hours logged by other users.



Date	Project	Activity	Hours done	Description	Status
24/09/2014	Kitchen remodel	04.07. Install sink and f...	16		Ok
30/09/2014	Kitchen remodel	03.01. Purchase new a...	8		Ok
30/09/2014	Software Development	Scope	10	Define the final version of the project sc...	New

Figure 17. User interface of the Logging Working Hours application.

**Future development.** It was decided to leave for further development the following features: Project Template, Critical Chain Management, Work Effort Estimation and Schedule Planning, Add Link Type to the Activities and Creating Activity Relationship in Gantt Chart. Some of them were rejected because of time constraints, as in the case of Project Template. Considering other features, it was agreed that they can be considered for development at some point in the future if there are requests from the customers.

## 6.2 Comparing MFPM to Other Project Management Tools

**Scope management.** Since for scope management the most important entities are the documents, where the scope and project requirements are defined, recorded, validated and controlled, it is important to have solutions for these activities. The most complete set of solutions for this project management aspect is given by MFPM. It provides the project manager with different classes of document type, so that the scope can be better organized and managed. In addition the document workflow can be set to define the current state of the document – draft, reviewed or approved.

Basecamp also allows a straightforward document attachment to the project, but managing the documents is rather limited in options. Moreover, if the project becomes more complex and requires more time to finish it, the number of discussions and documents in Basecamp can become an issue for finding the right document or message. This is due to the fact that Basecamp organizes its objects in chronological way.

Managing scope documentation in Microsoft Project in turn, requires additional efforts and resources. However, in case the WBS creation is needed, then Microsoft Project provides the quickest and simplest way to define and track their hierarchical structure. In contrast, MFPM uses metadata to organize the objects. Using metadata as a searching criteria is much more effective, as it can be strictly specified what exactly the result should be. Furthermore, depending on the metadata level of detail, the search results can be refined accordingly.

**Time management.** As time management is a critical aspect in any project management, all three systems provides solutions for time related issues. Nevertheless, Microsoft Project has the most complete list of technique to address the time management. Basecamp, in turn, can extend its features with third-party applications. MFPM provides metadata properties, objects and predefined schedule statuses, as well as several applications for time management. For instance, the highly-customizable Gantt chart can display all time critical objects. More than that, MFPM allows the developers to create their own time related applications.

**Cost management.** Considering the cost management, MFPM has the most accomplished list of features to address the cost related matters. For instance, dedicated metadata properties, objects and predefined values for budget statuses can be defined for this purpose. However, it is limited in the sense that it does not provide means for analytical estimation of costs or budget.

Nonetheless, controlling the cost and budget is provided by the Project Dashboard application. In contrary, Microsoft Project allows to estimate the costs and budget, as well as controlling them. Even though, it has less options for defining them, as provides a limited set of type of costs. Basecamp, in turn, can allow handling the cost related tasks only with third-party applications, which makes it the least useful in this context.

**Quality management.** Quality management is addressed by these three project management systems, in a similar way as the scope management. This is due to the fact, that quality management, as well as scope management, has to deal mostly with documentation. In this way, MFPM gives better metadata-driven solutions. Basecamp, in turn, allows storing and proper management for a limited number of documents or third-party applications shall be used. Finally, Microsoft Project requires integrations with other Microsoft tools for storing, sharing and managing the project documentation.

**Risk management.** MFPM is the only system that provides solutions for risk management. In addition to the dedicated object with risk related properties, the project dashboard provides the risk matrix and the list of critical risks. This allows the project manager to stay focused on critical risks and perform timely perform risk responses. While Microsoft Project does not have any means for risk management, in Basecamp storing the risk related documents can be helpful.

**Change management.** Change management activities are best addressed in MFPM. It is the only system out of the three discussed here which has automation means for change requests. In addition, change impact on the project can be analysed using the project baselines. Baseline has certain solutions for change management, e.g. dedicated discussions and attached documents. However, even these may become of no use or misleading when the project lifespan becomes longer. Microsoft in turn, provides only guidelines for manual change management.

**Documentation management.** Considering the metadata-driven approach used in MFPM, it is clear that document management is addressed at the highest level comparing to the other discussed project management systems. While MFPM provides various solutions for creating, storing, versioning, managing and controlling the project documentation, Microsoft Project and Basecamp have significantly fewer options.

**Communication means.** Having in consideration the concept of Basecamp which is based on the idea of blogging, it is clear, that communication is the best implemented in this project management software system. However, with the latest version of Microsoft Project, Lync instant messaging application can be used directly from the project. With regard to MFPM, it can be mentioned that no direct communication means are included now in the system. However, due to sharing solutions, minimum remote communication might be needed, when managing a project with MFPM.

### **6.3 Case Studies Findings and Analysis**

This section is aimed to provide an overview of the interview conducted with the Senior Manager from M-Files [Käppi, 2014]. During the interview he provided valuable information regarding the adoption of MFPM and other M-Files systems for project management in various enterprises. This section is also providing an analysis of the findings, based on the background about project management and metadata, given in the thesis.

At the time of writing the thesis, MFPM was available for sales people within the M-Files Corporation to demonstrate it for prospective customers for around two months. Main focus when demonstrating it to the customers was made on the "best practices" for project management. Specific features of the system, parts of the metadata structure and metadata advantages are things that have been presented as "best practices".

During this time, the system was also procured by and deployed to several enterprises. Depending on the customer's need, it was either partially integrated to an already existing vault or brought into service as a separate vault. In most of the cases, approximately 50% to 70% of the MFPM features and structure was adopted. In addition, other functionalities have been implemented, in order to meet customer's requirements.

In most cases the MFPM has been used not only as project management dedicated system, but as a more general and all-embracing system. In other words, the vault has been used to manage all the data available electronically. They found it best for managing company documentation, various type of resources, as well as business processes of the company.

One of the purposes of MFPM was to include most of the means that are necessary in project management process. Since every project is a unique one, as it was mentioned previously, they might require unique tools, so this is a tough task. Another reason might be the technical aspects. For instance, communication tools, such as emailing or other messaging application, were not yet implemented as a part of M-Files.

Considering this, certain communication tools have been used along with MFPM. Nevertheless, due to integration possibilities that were mentioned above, email messages can also be accessed within MFPM. Furthermore, if the communication is performed with an external stakeholder, Web Access has been used to provide links to the latest version of the documents or other attachments. In addition, the Web Access has been used to make available the latest status and progress of a certain project activity for the appropriate stakeholders.

One of the most important goal of MFPM was to increase the productivity of project management and project implementation. Considering the nature of projects in the enterprises the MFPM was adopted for, it is hard to say for sure at this point whether the goal was achieved or not. For instance, the projects' lifespan range in one of the companies, which is involved in customer delivery projects (company A), has been between 4 weeks to 6 months.

On one hand, since MFPM was introduced, they were able to cut down certain time-consuming activities and were able to significantly rise the productivity. Examples of such tedious tasks can be figuring out from various sources at different point of time the right or latest version of requirements document, who is doing what, when are the dead-lines, and so on. In other words, due to the visibility of the system, team members are more focused on the actual work related to project implementation, rather than discussing the obvious things over and over again.

On the other hand, with the growing complexity and lifespan of the project, the visibility is also affected in a negative way. For example, in an engine manufacturing company, which has also been using MFPM (company B) the projects might last for several years. As a clear fact, in this time the documentation gets quite extensive, the tasks and other long-lasting activities might get tough to track.

Nonetheless, due the Refinement principle, versioning and workflows the visibility can be balanced according to the needs of the project team members. Company B has been successfully using M-Files for several years now and is reporting a better performance since then. By adopting also MFPM, they are expecting a more increased efficiency due to the use of additional analytical features.

An important aspect that might as well affect the productivity and is always taken into consideration when adopting new tools and/or systems, is the learning time and complexity. In case of MFPM, it was found out that the learning time was not longer than with any other project management tool that has been used in the enterprise before or along MFPM. However, this applies to companies that have been using M-Files previously, thus were familiar with metadata concepts. Otherwise, trainings were provided to end users, in order for them to take the most advantage of metadata capabilities.

An interesting fact that was observed is the team size does not really matter and does not make the project management more complex in any way. What is more, the team location is also not a concern. Company B has been managing various projects, having in the average 100 team members. Similarly, company A has been managing projects in which the teams' size was varying and have been both dispersed and located in one place. Both companies mentioned they did not experience any kind time lags or other inconveniences in project management if the teams got extended or geographically distributed.

A fact worth mentioning here is that before adopting MFPM or other M-Files System, most of the companies had been using Microsoft Project as a project management tool. In case of company B, Microsoft Project was also one of the tools used along with special in-house applications. For this particular company, M-Files is the sixth provider of the project management system. However, initially, the Board of Directors denied the M-Files solution.

The reason behind this, were the arguments coming from the IT department. The arguments stated that M-Files does not have a full integration with SharePoint, which is essential for the company management. The decision of the Board of Directors was, however, ignored by the Engineering department. They started to use a Cloud based version of M-Files internally.

Consequently, it turned out that they can achieve a better performance, have a more transparent document management than with previous solutions. The decision of the Board of Directors decision was eventually revised and M-Files was introduced to the rest of the enterprise. SharePoint integration implemented in M-Files was decided to be enough for company purposes.

## 7. Conclusions

Projects are currently the basis of any organization, and project outcome is the factor that defines the success and growth of the organization. Therefore, project management became the most essential activity in ensuring a timely, high quality and within budget project outcome. In order to achieve a more effective and productive project management process, project managers adopt various dedicated software tools aimed to automate certain project management activities. Considering this and the growing complexity of projects and the uniqueness of the projects outcome, a constant search for the new approaches in project management software is required.

The goal of this thesis was to implement a metadata-driven project management system and analyse the impact of metadata usage on project management and project implementation productiveness and effectiveness. Implementation was carried out for M-Files Corporation as a concept at first and continued as a fully functional system. Later on, as the system got deployed to and used by certain customers, an interview with a Senior Manager was conducted to find out whether there have been changes in effectiveness of project management and implementation at the customer side.

Despite the fact that at the time the interview was conducted, the system was in use for only two months, there are already certain positive results. The positive results were also possible to achieve due to the fact that most of the enterprises were already using M-Files products as a data management solution. This implies also previously usage of M-Files to manage specific project related documents and other data. This came in handy, when the new features of MFPM were introduced, as the employees required less time for learning. Learning time is one of the factors that can affect the project management productiveness and it was successfully addressed in these particular cases. Considering the probability of adoption in an enterprise which did not had previous experience in working with M-Files, it is worth mentioning, that trainings are provided, so that the learning curve is minimal.

Considering the project management knowledge areas, it was found out that most of them are performed with an increased productivity. In particular, when a certain process requires a document to be updated, verified or otherwise manipulated, metadata was the solution to address the commonly experienced issues related to document management. In other words, searching for the right version of the document, finding out the due date for it, collaborative work on documents, among other challenges, are well addressed by metadata.

In addition, M-Files applications developed for MFPM provide analytical functionality required in project management. In this way, the effectiveness is achieved by automating some tasks that the project manager would have to do manually or using other software solutions. For instance, risk matrix, current status of the cost, budget, schedule, are shown in the project report, so the project manager does not have to process all that data separately. This allows the project manager to focus more on decision making and improving the management and implementation methods.

To summarize, the results of this study showed that metadata can increase the productiveness and effectiveness in project management and implementation. Due to the high level of customization that is provided by M-Files technologies and the nature of metadata, the implemented system can meet the requirements of any project, regardless of the business area. If properly deployed and adopted, the metadata-driven system can bring significant advantages, comparing to other project management software solutions.

While searching for similar metadata-driven solutions, it was noted, that there are no evidences of a previous similar work. This fact led to insufficient comparison of project management tools. In contrast, there is a big number of various project management software applications with different approaches. This fact led to certain difficulties in making a decision about which of them to include in the review. Considering this, the review may seem to be as not complete as it could be.

The thesis project was implemented in a practical setting, and as it can be expected, the developed system was needed as soon as possible. The requirement to have it quickly, caused particular features to be rejected from the project scope. In addition, as the thesis writing was started at the same time as the implementation, by the time the system was started to be deployed, there was already the need in study results. In this condition, the analysis part of the thesis is done based on two months experience with the MFPM from a limited amount of customers, which in terms of project management is not enough to fully understand the impact of the new approach on productivity and efficiency.

As a recommendation for further work, the features not included in the implementation list should be considered and their impact on the project management analysed with the survey that can be found in Appendix 1. Considering the time constraints to receive feedback from the project managers that used the new system, an extended investigation is required in order to consider the various types of projects in terms of lifespan, goals, methodologies, team size and composition, among others. In addition, comparison with more project management software tools could be beneficial to discover other functionalities that would facilitate the tasks of the project manager.



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**M-Files Project Management System User Survey**

1. For how many years have you been a project manager?
  - a. < 1
  - b. 1-4
  - c. 4-10
  - d. > 10
2. How many projects did you manage?
  - a. 1-5
  - b. 5-10
  - c. 10-30
  - d. > 30
3. What was the most common number of the team members in your projects?
  - a. 1-5
  - b. 5-10
  - c. 10-30
  - d. > 30
4. What was the most common lifespan of your projects (in months)?
  - a. < 1
  - b. 1-6
  - c. 6-24
  - d. > 24
5. What systems/tools have you been using for project management during your career as a project manager?
6. For how long have you been using the MFPM (M-Files Project Management) (in months)?
  - a. < 1
  - b. 1-6
  - c. 6-24
  - d. > 24
7. For how many projects have you been using MFPM?
  - a. 1-5
  - b. 5-10
  - c. 10-30
  - d. > 30
8. How long have been the projects, for which you used MFPM (in average, in months)
  - a. < 1
  - b. 1-6

- c. 6-24
  - d. > 24
9. How many team members were in the projects managed with MFPM? (in average)
- a. 1-5
  - b. 5-10
  - c. 10-30
  - d. > 30
10. What are the other systems/tools that you have been using along with MFPM for project management?
11. Did the learning on how to use the MFPM affect the project management?
- a. Yes
  - b. No
12. Did you have previous experience in using metadata-driven systems?
- a. Yes
  - b. No
13. How did MFPM affect the productiveness of project management? Consider the work done only by you as a project manager.
- a. Project management was more productive
  - b. Project management was less productive
  - c. Project management productiveness was not affected
14. How did MFPM affect the productiveness of project development? Consider the work done only by other team members.
- a. Project development was more productive
  - b. Project development was less productive
  - c. Project development productiveness was not affected
15. How did MFPM affect the implementation of the project scope? Compare the projects managed with MFPM and project managed with other systems/tools and consider the average ratio of completed and left out work for each project.
- a. More work was completed
  - b. Less work was completed
  - c. Same amount of work was completed
16. How did MFPM affect the schedule management? Compare the projects managed with MFPM and projects managed with other systems/tools and consider the schedule planning and tracking in overall for each project.
- a. Schedule was both easier to plan and track
  - b. Schedule was easier to plan, but harder to track
  - c. Schedule was harder to plan, but easier to track
  - d. Schedule was both harder to plan and track
  - e. Schedule management was not affected

17. How did MFPM affect the project costs? Compare the average ratio of planned and actual costs for projects managed with MFPM and projects managed with other system/tools.
  - a. Less costs were spent
  - b. More costs were spent
  - c. Costs were not affected
18. How did MFPM affect the project outcome? Compare the project outcome quality and customers' satisfaction for projects managed with MFPM and projects managed with other system/tools.
  - a. Both, the project outcome quality and customers' satisfaction were higher
  - b. Project outcome quality was higher, but customers' satisfaction lower
  - c. Customers' satisfaction was higher, but project outcome quality lower
  - d. Both, the project outcome quality and customers' satisfaction were lower
  - e. Project outcome was not affected
19. How did MFPM affect the use of information about the project risks? Compare the project risks for projects managed with MFPM and projects managed with other system/tools.
  - a. Information was more valuable
  - b. Information was less valuable
  - c. Use of information about risks was the not affected
20. How did MFPM affect the change management? Compare the change management for projects managed with MFPM and projects managed with other system/tools.
  - a. Change management was easier to perform
  - b. Change management was harder to perform
  - c. Performing the change management was similar as in other systems/tools
  - d. Change management was not affected
21. How did MFPM affect the document management? Compare the document management for projects managed with MFPM and projects managed with other system/tools.
  - a. Document management was easier to perform
  - b. Document management was harder to perform
  - c. Performance of document management was the same
  - d. Document management was not affected
22. How did MFPM affect the resource management? Compare the resource management for projects managed with MFPM and projects managed with other system/tools.
  - a. Resources were both easier to plan and track
  - b. Resources were easier to plan, but harder to track

- c. Resources were easier track, but harder to plan
  - d. Resources were both harder to plan and track
  - e. Resource management was not affected
23. If you had geographically dispersed teams, compare how did the MFPM affect the project management for these projects and for projects with local teams?
  24. If you had geographically dispersed teams, compare the project management with MFPM and with other systems/tools.
  25. Did you use MFPM to interact with the customer? Consider sharing documents, managing meetings, among other types of interaction.
    - a. Yes
    - b. No
  26. Mention the advantages of MFPM comparing to other project management systems/tools.
  27. Mention the disadvantages of MFPM comparing to other project management systems/tools.
  28. Comment, how can MFPM be improved and how would that improvement affect the project management with MFPM.
  29. What is your overall impression about MFPM compared to other systems/tools?
  30. Mention any comments about MFPM and/or the survey.