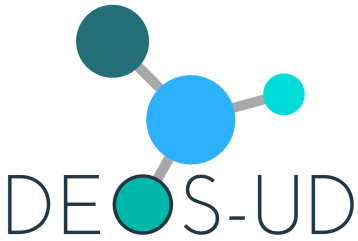

Project DEOS-UD

Disruptive Earth Observation Sensing for Urban Developement

Deliverable 2
Scope, Time and Cost Management

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1 Project scope statement

1.1 Product Scope Description

Earth observation is a field with a great potential that had not been taken into account until the last decade. Important space agencies like the European Space Agency are promoting the enhancement of capabilities with respect to Earth Observation due to the fact the society and the planet itself would benefit from the the many application it has. Hence, an improvement of the state-of-the-art technologies used for EO sensing is a key factor to promote and advance in this field. In other words, this project is not in charge of developing new launching systems or designing satellites, its objective is to provide the existing and the next generation of space technologies with disruptive sensors. In fact, one of the priorities it is to ensure the complementarity with other activities or programs such as Copernicus funded by the ESA too and lead to a strengthening of Europe's position and competitiveness in this field.

Moreover, to achieve the project goal an implement much better sensors than the already existing ones, a state-of-the-art of the current space requirements of several optical an radar systems is done. Once the limitations and the potential of the different technologies such as LiDAR, RADAR, Gravimetry, Hyperspectral, Superspectral and more are determined, it is possible to work with the most promising ones. Furthermore, the preliminary design will take into account several criteria to obtain competitive sensors. On the one hand, launching any payload to space has very high costs, then it is essential to ensure the endurance of the overall systems in order to maintain the payload in space for a long time and avoid any replacements. To accomplish it, the materials used to build the components of the sensor including antennas, photo-detector, optics, laser and electronics have to be accurately chosen.

Besides, Earth Observation can have many application, so it is crucial to focus on the enrichment of some of them to guarantee the development the desired sensor abilities. Indeed, as the goal is to apply EO sensing for Urban Development to integrate space in society, the abilities to enhance are the following ones:

- Detection of greenhouse gases.

- Detection of weather patterns.
- High precision performance of terrain 3D mapping.

On the one hand, systems as LiDAR, which combines technologies as laser and radar, enable to target a wide range of materials including clouds and molecules. Consequently, it is possible to develop a sensor that identifies the composition of the air to secure our environment by having a monitoring of either the greenhouse gases or the weather patterns for proper weather forecasting applications. On the other hand, 3D mapping of the terrain is useful to control the land and guarantee an optimum growth and development of the city. All in all, one of the most important aspects that have to be taken into account is that the sensors resulting from this project have to ensure at least a 15% increase of the reliability and precision compare to the current ones.

In addition, a step that is necessary in this kind of projects is the testing of the product. Once the preliminary design is finished an accomplish all the requirements, a first prototype is build and test in a space simulated environment to make sure that it performs as expected. Notice that the testing is not done in the space itself because launching the prototype to the space is to expensive and out of this project budget; fortunately, there are other methods that are cheaper an simulate properly the space conditions. Finally, once the prototype designed fulfil all the expectations, it is considered that the results are attained and the product design is ready for closure.

1.2 Project Deliverables

All the deliverables specified in the Table 1.2.1 will be submitted to the European Commission during the development of the project.

Deliverable Name	Description
Project Management Plan	Document with detailed explanation of the project management strategies, including the Project Charter, stakeholder register, risk, quality and financial plans.
Communication Plan	Document containing all the planned dissemination strategies, such as the online communication (including website development and social media management), the offline communication (participation in meetings and conferences) and the dissemination materials (technology demonstrators).

Deliverable Name	Description
Payload State of the Art	Report containing the state of the art of current EO remote sensors as well as the sensors to improve selection and the first requirements definition.
Modular System State of the Art	Report containing the state of the art of current modular systems with space applications and its first requirements definition.
Space Applications State of the Art	Report containing the state of the art of current urban development space applications and first interaction platforms requirement definition.
Payload Preliminary Design	Report determining the payload preliminary design. It contains the research, requirements and preliminary performances parameters of each sensor.
Modular System Preliminary Design	Report detailing the modular system preliminary design. It includes a first review of the sensors blocks physical framework and sensors data fusion software requirements as well as the initial definition of the SATCOM application domains.
Interaction Platform Preliminary Design	Report detailing the interaction platform preliminary design. It includes the predesign of data sharing servers and platforms as well as the definition of the initial implementation of data processing algorithms.
Mid-term Review	Document used to check the current state of the project, in order to inform all the participants, including the stakeholders, of the progress.
Payload Final Design	Report detailing the final design and technical specifications of each developed sensor.
Modular System Final Design	Report detailing the final design and technical specifications of the modular system.
Sensors Data Fusion Software	Final sensors data fusion software.
Interaction Platform Final Design	Report containing the final design and technical specifications of the interaction platforms.

Deliverable Name	Description
Data Processing Software	Final data processing algorithms based on applications to process acquired satellite data.
Validation	Report that gathers the tests and validations with the obtained results of all the payload sensors, the modular system and the interaction platform, as well as the full system performing.
Final Report	Final document that includes all the development done through the execution of the project.

Table 1.2.1: Project Deliverables

1.3 Project Acceptance Criteria

The acceptance criteria establish the requirements that must be met for the client to accept the project. These criteria are quantifiable, demonstrable and verifiable in such a way as to demonstrate that the project has been carried out properly, that is why, if these criteria are not met, a deliverable of the project cannot be considered valid.

Item	Description
Research and innovation	The project must be ambitious and use all the available resources to obtain the best result. In this way, it must include the most appropriate technology that there is so far and, if it is in the development phase, add a section of research.
Quality	The content of the project documentation must be clear, complete and understandable. Furthermore, it must be well structured, dividing the information into approach, development and conclusions. All the documentation included in the project must first pass through an inspection of the quality department.
Sustainability	The product must be sustainable using renewable energy as much as possible and avoiding excessively polluting emissions. The materials used in the project must be reliable and guarantee the agreed useful life of the product.

Item	Description
Schedule	The organization must be well structured and the deadlines must be met in a timely manner so that the development of the product is appropriate.
Social contribution	The product must be able to solve a current problem and improve the quality of life of people using technology.
Clarity	The tasks of the project must be well defined, both individually and as a group, in such a way that each of the contributors knows their duty and the duty of their team.
Test and validations	The evaluation and validation tests must be carried out periodically and be registered in the project documentation, in such a way that there is a record of the different versions of the application throughout the development. The information of these tests must be presented clearly and refer to the regulations concerned, in addition to be verifiable. The results of these tests should be used to analyze the service level of the application and improve on later versions.
Technical documents	The application must have a user manual both internally and externally and attach the necessary information for its development. The performance of the final product must be reflected in a data sheet. It must also be included in the documentation the datasheet of the different components that are part of the application.
Viability	The project must be viable economically and technically, so that its realization is possible. The different parts of the project must be submitted at the individual level to a study that checks if it is possible to do them and, if not, search for an alternative. The budget of the project must comply with the financial requirements of the European Union. Hence, a balance is to be made to ensure that the allowed limit is not exceeded.

Item	Description
Performance	The systems used in the project must be able to guarantee the right functioning of the application. An important aspect of the project is its performance, in this way, as it progresses, it aims to increase the efficiency and quantify this increase in the different phases.
Collaboration	It is interesting to obtain a better result to collaborate with legal entities from different countries, like universities and research groups. Moreover, some collaborations with SMEs should be tried, so that they can benefit and grow in the market.
Transparency	In case information about the project is required by part of official organisations of the European Union or by the different stakeholders that participate in it, transparency has to be considered when sharing information.
Gender equality	The selection process must be fair, based on the knowledge and personal competencies of each person regardless of gender or condition.
Legal requirements	The applications and products of this project must have, if required, the certification and approval of the different legislative and ethical frameworks.

Table 1.3.1: Acceptance criteria

1.4 Project Exclusions

There are some facts that are out of the scope of the project which, generally, are designated as exclusions. Hence, in this section, the exclusions of the project are determined and defined.

Item	Description
Satellites design	It is out of the scope of this project to design a new satellite that will use the sensors as payload.
Launching	The objective of the project do not include neither the design of the launch system of the satellites nor the costs and scheduling of launching the satellite using the sensors designed.

Item	Description
Deployment	No deployment mechanism nor strategy of the satellites that integrate this new technologies are going to be developed.
Satellite monitoring	The satellite monitoring system that permits to scan different surfaces and regions of the earth is not included in this project scope.
Data transfer	Neither communication between satellites nor between the satellite and the ground station are part of this project.
Final production	The project will only focus on the development of prototype models in order to test the new technologies implemented. Hence, commercial production of these ones will not be carried out.

Table 1.4.1: Project Exclusions

1.5 Project Constraints

Project constraints can be defined as all the limitations that curb the action of the project team and restrict project's outcome. It is necessary to define them with caution and common sense to avoid determining constraints that lead us to an impossible project, especially in terms of cost, time and resources. They can be internal limitations (scope, budget, etc.) or external limitations (environmental impact, stakeholders, government regulations, etc.)

In this project, we have decided to adopt a classification consisting on six groups [1] where constraints can be clearly interpreted and organised.

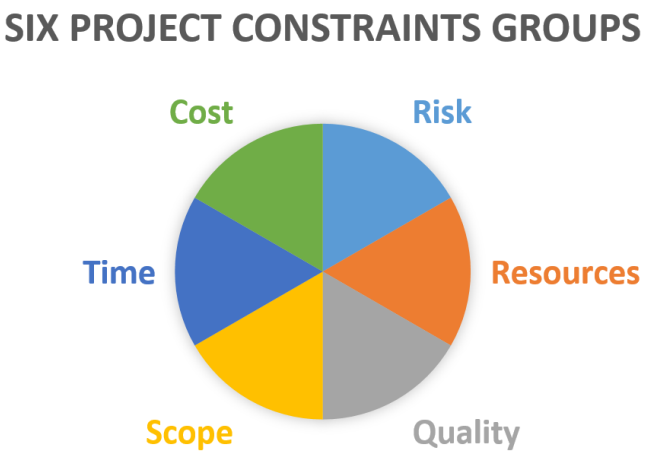

Figure 1.5.1: The 6 Project Constraints [1].

It is important to highlight that groups are interrelated in a way that if one of them changes, then, one or more of the others will be affected.

Scope

- **State of the art:** The starting point of the project has to be based on a study of the optical and radar cutting-edge technologies, not on outdated ones.
- **Technologies selection:** The technologies to be developed must be the most promising systems to profit Earth Observation, air composition and terrain analysis.
- **Technologies improvement:** The project is required to enhance the selected technologies in order to accomplish the European Commission requirements.
- **Final design:** The resulting design has to be a compact product which contains the chosen sensors, sharing a data collection software.

Time

- **Deadlines:**
  - **Project Management, business and communication plans deadline:** Expected execution time is determined in 1 month and a maximum of 2 months is permitted within the project limitations.
  - **State of the art report deadline:** Its elaboration should last 4 months as initially foreseen and not more than six months duration will be admitted.
  - **Preliminary designs deadline:** Payload, modular and interaction preliminary designs must be completed at utmost one year and a half (although forecasted to last for 16 months).
  - **Mid-term project report deadline:** Maximum duration of two years but expected to be fulfilled in 22 months.
  - **Final designs deadline:** Payload, modular and interaction final designs must be completed at utmost 30 months (although forecasted to last for 29 months).
  - **Prototype manufacturing and system testing:** Approved maximum duration of three and a half years estimated period of 41 months.
  - **Final report deadline:** Limited duration of 4 years. Expected to be delivered in 44 months.
- **Schedule:**

  - **Follow Gantt chart organization:** Tasks must be developed in the initially accorded order, avoiding undesired overlapping or delays and bringing the requirements of each task to their completion.

Cost

- **Budget:**
  - All the incomes have to come from the European Commission.
  - The project cannot exceed the quantity of 4 million euros.
  - The money distribution must be done as it was described in the estimated budget.

Resources

- **Facilities:** No tasks will be planned without the certainty that the team (or a stakeholder) has the necessary facilities to complete it.
- **Human resources:** All the labour hours made by the staff in charge of the project must be justified. Every task will have assigned a different number of workers depending on the difficulty and duration.
- **Infrastructures:** The work to be done by the team is restricted by the capacity, limitations and efficiency of the owned infrastructures.
- **Procurement:** Goods and services will be obtained following optimized processes to achieve minimum cost while at the same time requirements are properly fulfilled.
- **Technical constraints:** The developement of the new technologies that the product will use will be restricted by technical, physical and scientific limitations.

Risks

- **Risk tolerance:** The amount of risk that the project must handle has to be low. It means that if some risky event has a low probability to happen, the impact can be low or moderate. On the other hand, if the event has a high probability to happen, the impact must be low.
- **Actions:** When some risk becomes a real problem for the project, the necessary measures have to be taken. These must affect as little as possible to the other constraints, such as cost or time.

Quality

- **Legal constraints:** All the systems developments and tests must be carried out under the corresponding standards.
- **Methodology:** The project must be developed following a methodology based on the use of state of the art technologies, research and improvement of the current capabilities of the earth observation systems.
- **Organization:** To obtain the required quality, communication between departments, communication with stakeholders, and the use of project management software assistance is a must.
- **Stakeholders' expectations:** External constraints imposed by stakeholders must be accounted in the project. In addition, the agreements with each of them must be accomplished.
- **Customer satisfaction:** The final product must fulfil the stablished requirements to obtain the customer satisfaction.

2 Work Breakdown Structure (WBS)

1. PROJECT MANAGEMENT
    - 1.1. Development project management plan
    - 1.2. Monitoring of the project
        - 1.2.1. Meetings
        - 1.2.2. Task tracking and scheduling
    - 1.3. Annual reporting
    - 1.4. Project implementation of risk management
2. QUALITY AND ADMINISTRATION
    - 2.1. Human Resources
        - 2.1.1. Employment of the necessary staff
        - 2.1.2. Human resources management
    - 2.2. Financial Plan
        - 2.2.1. Costs
            - 2.2.1.1. Fix
            - 2.2.1.2. Variable
        - 2.2.2. Funding
        - 2.2.3. Economic feasibility
        - 2.2.4. Evolution monitoring
        - 2.2.5. Additional and follow-up funding seek
    - 2.3. Documentation Management
        - 2.3.1. Guidelines preparation
        - 2.3.2. Document revision
        - 2.3.3. Document rectification

2.1 Activity list

WBS-ID	Activity	Description of Work
1.	Project Management	All activities related with the management of the project fall under this activity.
1.1.	Development of the project management plan	Elaboration of all the documentation that states the strategy of the management and organization of the project through its duration.
1.2.	Monitoring of the project	Control of the progress of each activity of the project.
1.2.1.	Meetings	Gathering of the members of the project to inform each other of the progress.
1.2.2.	Task tracking and scheduling	Tracking of the active tasks and scheduling.
1.3.	Annual reporting	Every year that the project lasts will call for the elaboration of an internal report with the aim of keeping up to date with the progress done.
1.4.	Project implementation of risk management	Study of all the potential risks and how will they be managed so that their affectation to the project stays to a minimum.
2.	Quality and Administration	Activities related to the administrative aspects of the project and to assure the quality of all the documents presented.
2.1.	Human resources	Administration of all the employees needed to fulfil the different tasks of the project.
2.1.1.	Employment of the necessary staff	Definition of the number of employees necessary.
2.1.2.	Human resources management	-.

WBS-ID	Activity	Description of Work
2.2.	Financial plan	Lay down of all the planned costs of the project, the funding expected from the various sources, a study on the economic feasibility of the project and a plan for additional funding search.
2.3.	Documentation management	The quality of the documents that have to be delivered through all the duration of the project is guaranteed in this activity by establishing guidelines for the redaction of all the documents, their revision and posterior rectification and final approval.
2.4.	Periodic monitoring	To ensure the quality of the project, a periodic monitoring of all the activities will be carried out.
3.	State of the Art	Before starting the design and research it is key to have an accurate vision of the actual state of the technology that is going to be developed.
3.1.	Payloads	For each of the sensors that are planned to be improved there is a search of the current space applications, that help defining the requirements for these sensors.
3.2.	Modular system	For the modular system where each sensor will be mounted on there will be a search of current similar systems in space applications and the definition of the requirements for the one developed in this project.
3.3.	Urban development applications	The search for current applications similar to those that want to be implemented with this project has to be carried out, in the weather forecast area, the urban planning area and the greenhouse emissions reduction area, thus defining the requirements for the applications.
4.	Product development	All the phases of the development of the product are included in this activity, from the research up to the final technical specifications.

WBS-ID	Activity	Description of Work
4.1.	Preliminary design	This first phase of the development is meant to include all the research and definition of the initial parameters of the different components.
4.1.1.	Payloads' preliminary design	The research and initial development of each sensor that is intended to improve is carried out in this phase.
4.1.2.	Modular system's preliminary design	Includes the initial development of the physical framework for sensor blocks, of the systems' interaction and applications, of the sensors' data fusion software and the definition of the satellite communications applications domains.
4.1.3.	Interaction platform's preliminary design	Implementation of the web-based servers for sharing sensor's data, of the processing algorithms based on applications and the pre-design of a full services stakeholders platform.
4.2.	Final design	This final phase of the product's development will define the final technical specifications of each part of the product.
4.2.1.	Payloads' final design	The design of each sensor is complete and its final technical specifications are defined.
4.2.2.	Modular system's final design	The design of the modular system and the sensors' data fusion software is complete and their final technical specifications are defined.
4.2.3.	Interaction platform's final design	The design of the interaction platform is complete, including the web based servers for data sharing, the processing algorithms based on applications and the full services stakeholders platform, and their final technical specifications are defined.
5	Simulation, testing, validation and quality	Activities regarding the simulation, testing, validation and quality control of the final product are included in this task.

WBS-ID	Activity	Description of Work
5.1	Technology demonstrator prototype manufacturing	Manufacturing of the prototype of the product, including all its subsystems (payload sensors, modular system and interaction platform), in order to be tested in the following activities.
5.2	Payload validation	Validation of the performance of the sensors mounted on the system.
5.3	Modular system validation	Validation of the modular system performance, of the systems interaction, of the sensors' data fusion software, of the satellite communications applications domains and also of the physical framework for sensor blocks.
5.4	Interaction platform validation	Validation of the interation platform to check if it develops all its functions properly.
5.5	Full system prototype validation	Validation of the whole system using the prototype in order to test its performance.
5.6	Quality of the product	Quality control of all the subsystems of the product and all the methodologies applied on its manufacturing and validation.
6	Business planning and exploitation of results	The activities regarding the final explotation and business planning of the product are included in this task.
6.1	Market approach	Study of stakeholders, procurement conditions negotiation and purchase of the resourses in order to study the feasibility of the project.
6.2	Exploitation and business plans	Includes the business plan of the product to exploit its economic potential.
7	Communication and dissemination strategies	Includes all the activities regarding the dissemination of the product inside the market.
7.1	Dissemination and communication plan	Definition of the strategies planned to the dissemination of the final product.
7.2	On-line dissemination activities	Include activities as the creation of a web site and the social media management.

WBS-ID	Activity	Description of Work
7.3	Off-line dissemination activities	Participation in conferences and meetings about the field of the technology.
7.4	Dissemination materials	Production of all the materials that will help to the dissemination of the product, as technology demonstrators or audio visual productions.

3 Sequence activities

3.1 Dependencies or logical relationship between activities

3.2 Network Diagram (Precedence Diagram Method)

4 Estimate activity resources

4.1 Resource identification

In this section the resources available/needed to perform the project will be exposed. These resources will be classified into three different categories:

- Employees: People needed to achieve the objectives of the project. The employees will be provided by the members of the consortium. As not all employees are in the same point on the learning curve, they will be classified into three sub-groups:
  - Senior: High on the learning curve. They are able to provide guidance on technical and management issues and offer a critical point of view of the actions of the project.
  - Average: They are able to perform activities on their knowledge field and arrive to conclusions without supervision.
  - Junior: Little experience in the field, the work done needs to be supervised by an average employee.
- Materials: Hardware and software elements that will be used to achieve the project objectives.
- Facilities: Special places and services (such as the testing room).

The resources are exposed in Table 4.1.1.

Resource ID	Resource Description	Type of resource
PM.M	Project Manager	Employee-Senior
PM.S	Project Manager Secretary	Employee-Average
F.M	Financial Manager	Employee-Senior
F.A	Financial Manager Assessor	Employee-Average
SP.M	Stakeholders and Procurement Manager	Employee-Senior

SP.A	Stakeholders and Procurement Manager Assessor	Employee-Average
ST.M	Scope and Time Manager	Employee-Senior
ST.A	Scope and Time Manager Assessor	Employee-Average
R.M	Risk Manager	Employee-Senior
R.A	Risk Manager Assessor	Employee-Average
QM.M	Quality Manager	Employee-Senior
QM.A	Quality Manager Assessor	Employee-Senior
MC.M	Marketing and Communications Manager	Employee-Senior
MC.A	Marketing and Communications Manager Assessor	Employee-Average
TM	Tecnhical Manager	Employee-Average
RD.A	Research and development assessor	Employee-Average
LB.A	Legal and Business Assessor	Employee-Average
SD.S	System development engineer	Employee-Senior
SD.A	System development engineer	Employee-Average
SD.J	System development engineer	Employee-Junior
ST.S	System testing engineer	Employee-Senior
ST.A	System testing engineer	Employee-Average
ST.J	System testing engineer	Employee-Junior
AD.S	Application development manager	Employee-Senior
AD.A	Application development technician	Employee-Average
AD.J	Application development technician	Employee-Junior

Table 4.1.1: Resources identification

4.2 Activity resource requirement

WBS-ID	Resource ID	Quantity	Assumption
Activity ID from WBS	Resource Code	Amount needed	Include any assumption specific to resource requirement

Table 4.2.1: List of resource requirement

Comments
Blablabla

4.3 Resource Breakdown Structure

1. Employees
    - 1.1. Project management
        - 1.1.1. Project Manager
        - 1.1.2. Project Manager Secretary
    - 1.2. Financial
        - 1.2.1. Financial Manager
        - 1.2.2. Financial Manager Assessor
    - 1.3. Stakeholders and Procurement
        - 1.3.1. Stakeholders and Procurement Manager
        - 1.3.2. Stakeholders and Procurement Manager Assessor
    - 1.4. Scope and Time
        - 1.4.1. Scope and Time Manager
        - 1.4.2. Scope and Time Manager Assessor
    - 1.5. Risk
        - 1.5.1. Risk Manager
        - 1.5.2. Risk Manager Assessor
    - 1.6. Quality
        - 1.6.1. Quality Manager
        - 1.6.2. Quality Manager Assessor
    - 1.7. Marketing and Communications
        - 1.7.1. Marketing and Communications Manager
        - 1.7.2. Marketing and Communications Manager Assessor
    - 1.8. Engineering
        - 1.8.1. Technical Manager
        - 1.8.2. Research and Development assessor
        - 1.8.3. Development
            - 1.8.3.1. System development engineer senior
            - 1.8.3.2. System development engineer average
            - 1.8.3.3. System development engineer junior
        - 1.8.4. Testing
            - 1.8.4.1. System testing engineer senior
            - 1.8.4.2. System testing engineer average

1.8.4.3. System testing engineer junior

1.9. Application development

1.9.1. Application development manager

1.9.2. Application development technician average

1.9.3. Application development technician junior

2. Materials

3. Facilities

5 | Estimate activity duration

6 | Project Schedule

Gantt chart

7 | Activity Attributes (at Work Package level)

Table 7.0.1: Activity X attributes

<table>
<tr><td colspan="2">WBS-ID:
This identifies where this activity can be found in the WBS.</td><td>Activity:
This is the name of the activity from the project activity list.</td></tr>
<tr><td colspan="3">Description of Work:
This information includes a detailed description of the work to be performed for this activity and should be consistent with what is provided in the project activity list.</td></tr>
<tr><td>Predecessors:
This section lists other activities which must occur before this activity.</td><td>Relationship:
This describes if the predecessor has a start-start, start-finish or other type of scheduling relationship.</td><td>Lag:
This section describes any dependencies on predecessor activities like lead times, lag times or other requirements.</td></tr>
<tr><td>Number and Type of Resources Required:
The number and roles of people to complete the work</td><td>Skill Requirements:
The level of skill necessary to complete the work (expert, average, novice or applicable job level)</td><td>Other Required Resources:
Any equipment, supplies, or other type of resources needed to complete the work</td></tr>
<tr><td colspan="3">Type of Effort:
Indicate if the work is fixed duration, fixed amount of work or fixed amount of effort</td></tr>
<tr><td colspan="3">Location of Performance:
If the work is to be completed somewhere other than at the performing organization site, indicate location</td></tr>
<tr><td colspan="3">Constraints:
Indicate any fixed delivery dates, milestones or other constrains</td></tr>
<tr><td colspan="3">Assumptions:
List any assumption about resources availability, skill sets, or other assumptions that impact activity</td></tr>
</table>

8 Cost estimating

8.1 Level of accuracy

8.2 Cost estimation worksheet

8.3 Activity cost estimation

9 Cumulative costs

9.1 Cumulative cost curve

9.2 Budget at completion

10 | Bibliography

[1] Workfront. The 6 Project Constraints, 2017.