Determining the success of innovative projects using performance and complexity indicators

Case: 'Project ARA'

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Bachelor Thesis for Bachelor of Arts & Business Administration (Hon.) - Double Degree

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Preface

I chose this topic according to an inspiring video I came across a couple of years ago, which I then followed up on shortly before starting my Bachelor thesis topic. This video was on the concept of ‘Phonebloks’. Since I had been following the progress for quite some time, I was curious about the outcome of the project. From this point the concept developed, that examining other case studies might be helpful to determine the outcome of ‘Project ARA’. I want to take the time to thank everyone that has supported me throughout this process and encouraged me on the way.

My father, Dr. Ingo Aller for very helpful corrections and suggestions, Dr. Thomas Finne and Helena Nordström for helping with the initiation process and giving feedback along the way. Furthermore, I want to thank Marcel Garciella, Constantin Altemeyer, Lina Hollsten and Christine Altmann for proofreading and insights on the topic. I also want to emphasize my appreciation of my family, my sister, brother and mother for the support and interest in my work.

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Abstract

The following Bachelor thesis was written to develop a model for determining the success of innovative projects, linked to the case study of 'Project ARA'. This will include various examination methods of the performance levels and the complexity of the projects, as well as a section on risk analysis. From the data of two successful and two failed projects, a standpoint towards the outcome of 'Project ARA' will be taken.

The two successful case studies are the Apple iPhone, 2007 and the Electric car: Nissan Leaf, 2009. The failed project data will be collected through the projects SNCF, 2014 and Airbus A380, 2006. Further on the case studies will be compared to 'Project ARA' and from the similarities and differences a conclusion will be drawn. Depending on the outcome certain governance factors of the most vital weaknesses of 'Project ARA' will be suggested.

Language: English Key words: Innovation, Technology, and Project Management, Project Success model

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Vorwort

Die folgende Bachelorarbeit beschäftigt sich mit dem Thema, ob es möglich ist den Erfolg von Projekten vorherzusagen. Als Anhaltspunkt wird ‚Projekt ARA’ analysiert. Da viele verschiedene Faktoren den Erfolg von Projekten beeinflussen können, werden die Kriterien Leistung und Komplexität untersucht. Die erhobenen Daten werden mit zwei erfolgreichen und zwei gescheiterten Projekten verglichen. Anhand der gesammelten Daten wurde versucht eine Voraussage zu treffen ob ‚Project ARA‘ ein Erfolg wird.

Als erfolgreiche Projektfallstudien wurden die Projekte Apple iPhone (2007) und Nissan Leaf (2009), das erste elektrische Auto ausgewählt. Zwei weitere Projekte, SNCF (2014) und Airbus A380 (2006) repräsentieren gescheiterte Projekte. Durch Vergleiche von Leistung und Komplexität zwischen den abgeschlossenen Projekten und Projekt Ara, konnte die vorherige Stellung angepasst und belegt werden. Daraufhin wurden die Schwachpunkte von ‘Project ARA’ durch ausgewählte Kontrollmethoden aufgelistet.

Sprache: English Schlüsselwörter: Innovation, Technology, Projektmanagement, Projekt-Erfolgsmodel

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1. Introduction

For a clear overview the first thing that has to be considered is the actual title of the presentation. If looked at closely there are four parts that need to be explained.

"Determining the success of innovative projects: Case Study 'Project ARA'"

The title of the project includes the application of major topics such as innovation and project management around which this thesis is focused. For analysis 'Project ARA', the centrepiece of this work, is compared with two successful and two non-successful projects in various criteria.

1.1. Innovation

Managing innovative projects has played an important role in the past and will be essential for developing and introducing new products and processes in the modern economy. Innovation describes the process of turning an idea or invention into a service that customers will pay for. This must be replicable at an economical cost which should eventually become profitable, invoking a buyers' purchasing power. In order to create innovation; information, imagination and initiative are combined in a product. Often these concepts are applied to the needs and demands of the customers.[1]

There are two types of innovation: evolutionary and revolutionary. Evolutionary innovation is the continuous process established through technological advances. Revolutionary innovation revolves around the principle that innovation is synonymous with risk-taking. When organizations create revolutionary products or technologies they take on a great risk because new markets are created.

1.2. Project management

Nowadays it has become fairly common to implement project management (PM) processes, skills and approaches into the business process. Yet there are still companies that shy away from these modern approaches. Often teams headed by senior management staff apply antiquated methods in everyday business life. In order to effectively apply PM a company has to determine to what lengths it can be applied in the specific situation, which depends

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[1] (Business Dictionary)

on the project size and nature. Overcompensation for small projects will annoy the employees and divert from the importance of key control features.[2]

Over the last decades[3], companies have learned to value project management and see it as part of future development. Not only has the application of PM strategies proven useful in reducing the investment in potentially failing projects, but the chance to identify possible problems early on and solve or monitor them has been created. Besides saving money, PM has also helped to improve on-time project delivery while bolstering customer relationships.

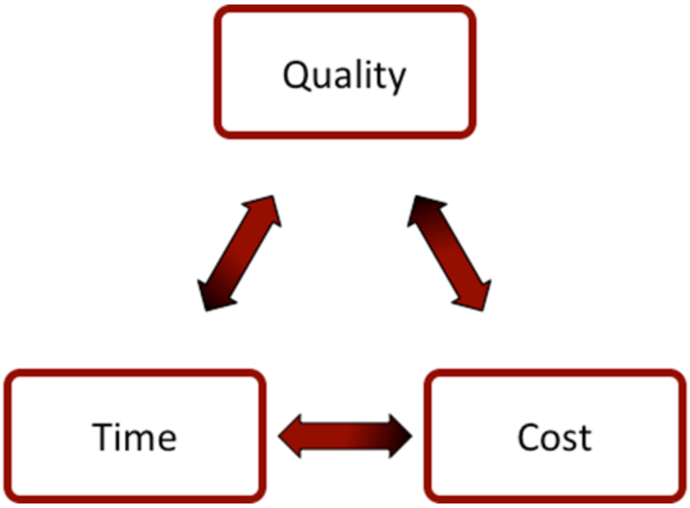

Figure 1: The triple constraint triangle, project management of time, quality and cost (Projektmanagement Manufaktur)

In order to understand the importance of project management the PM triangle, also called a triple constraint, needs to be considered. Figure 1[4] shows the three major constraints of managing a project. Time is defined by the timeframe for completion of the respective project. The cost factor is determined by the budget that a project has access to. Quality on the other hand describes the resulting product standards that are expected or set.[5]

When problems arise that threaten one of the three constraints, typically one of them is cut down, ideally without disturbing the other limits. So in case the finishing time of the project is threatened, the extra cost for organising more material or human resources can be considered. If the quality of the project is threatened, a costlier product or service can be bought, which might require more time. When determining the success of a project it is vital to analyse the difference between the initial constraining factors of the triangle and the

[2] (TenStep, 2014)
[3] (Aller, 2015/16)
[4] (Project Management Institute Inc., 2010)
[5] (QTC Control Services)

actual values after completion. The smaller the difference, the more efficient management methods and the project overall was.

The main reasons for a project's success[6] are focused around user involvement, executive management support and a clear statement of requirements. These three aspects are crucial to effectively plan and complete a project. A study states that 15,9% of reasons for successes are due to user involvement, 13,9% with executive management support and 13,0% with a clear statement of requirements. Other factors[7] may be linked with the involvement of the beneficiary, the support of managers and the overall grasp of requirements. Additionally, the expectations towards the project need to be realistic, with appropriate planning along the way.

In order to determine success factors, the main reasons for project failure have to be identified. Here the planning and estimation factor, if costs and schedules aren't revised over time can have a grave impact. Furthermore, if the implementation factor, where changes in scope, requirements or the project methodology and inspections are executed faultily or the human factor is managed with a lack of skill, the failure of the project becomes almost certain. The principal factors that contribute to a project's failure are named poor communication, attempting to fulfil unrealistic expectations and lack of resources.

1.3. 'Project ARA'

'Project ARA', which this thesis is centred around, is the R&D and initiation process of creating the first mass marketed modular cell phone. By teaming up DARPA employees, Google's advanced technology and knowledge product group and universities, a team of 150 people worldwide with 20 partners was created.[8] The current status is that the product has undergone four different stages, the 'Phonebloks' concept and the Spiral 1, 2 and 3 prototypes as of January 2016.

After only nine months a functioning prototype was created with only a 25% penalty, in terms of size, weight and battery life. The initial designer's, Cave Hakkens,[9] idea was implemented in the first modular phone of its type. With the goal to create a phone 'worth keeping' and thereby minimizing the toxic wastes mobile devices produce yearly, this is

[6] (Attarzadeh & Ow, 2008, S. 235)
[7] (Toader, Brad, Adamov, Marin, & Moisa, 2010, S. 449-452)
[8] (Eremenko, Project ARA DevCon2 Highlights, 2015)
[9] (Hakkens, Phonebloks - The ultimate phone concept, 12th Sept 2013)

considered a huge success. Additionally, the goal of individualization is met, despite the disadvantages of a lower battery life and thicker appearance.

1.4. Introductions to case study work

In order to collect comparative data, four different case studies were analysed. Two of these were successes, namely Nissan Leaf in 2009 and the Apple iPhone in 2007. The Nissan Leaf was the first zero-emission, battery powered car to ever enter the market.[10] The results were impressive, with a market launch about 1,5 years prior to the expected date. The Apple iPhone is similar in its success.[11] Initiated officially in 2005, based on an entry strategy in 2004, 200 top engineers were set on the task of creating a functioning device by 2007. Here the product was set to be the centrepiece of MacWorld. After a very late breakthrough in December 2006, they were able to keep the planned market entry in June 2007.

Moving on to the failed project cases. For this purpose, the projects SNCF, 2014 and Airbus A380, 2006 were chosen. SNCF, the French railway company initiated a project, where 2000 new trains should be introduced into the system.[12] Due to information loss in the communication process the overall result was $68 million more in terms of cost and a two-year delay. Since the trains were built too large for the rail width, 1000 station platforms had to be adjusted in size. The other failed case was Airbus A380, where a new R&D project, featuring a complex wiring system was to be implemented.[13] The 16 engineering teams were spread over four countries and ended up miscalculating the lengths and amount of material. This was mainly due to the fact that they used two different software versions. Overall the project took two years longer and cost and additional $6,1 billion.

2. Overview and purpose

The aim of this research paper is to create a model for determining the success or failure of a project, using previous case studies as comparative data. The initial introduction on the methodology and theory will include information on the Classification, Risk analysis

Performance and Complexity level measurements and the explanation of the comparative process.

[10] (NISSAN MOTOR CORPORATION, 2009-2013)
[11] (Vogelstein, 2008)
[12] (Callem Consulting LTD, 2015) (Willsher, 2014)
[13] (Callem Consulting LTD, 2009)

Figure 2[14] provides an overview of the general thought process behind this thesis. In the first step 'Project ARA' will be analysed. This step includes a general introduction of the project, after which the project will undergo a general risk analysis. Furthermore, the performance and complexity levels will be identified. From this a base, for comparison against the latter case studies, is created.

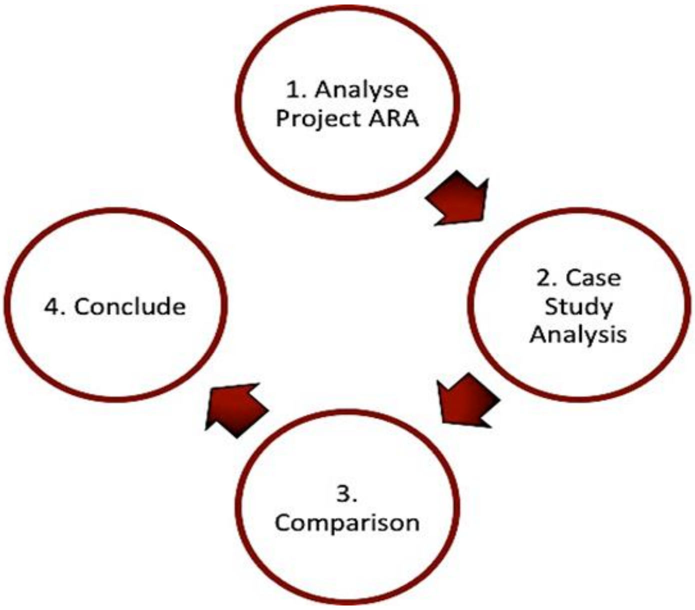

Figure 2: Four step model of thesis progress (Aller, 2015/16)

In the second step there will be an in depth analysis of two successful and two failed projects. For each one of them, the described methodologies will aim to classify the projects after a short overview of the respective facts and figures. Afterwards all projects will be subject to an analysis of performance and complexity levels. The data collected will provide an initial perspective on key success drivers that the projects share.

Thirdly the collected data will be compared. A preliminary standpoint will be taken on if 'Project ARA' is more likely to be successful or fail, according to the previous data. In order to harden this standpoint, the performance levels of all cases will be compared, paying special attention to the key success drivers. As second contributing factor to determining the success or failure of the project the complexity levels will be analysed. From all the collected data a graph will be drawn, which will map performance levels against complexity, aiming to form a trend line.

In the final point the data will be summarized, providing an overview of the outcome. From this the initial standpoint will be adjusted and any effects that the weaker points have on

[14] (Aller, 2015/16)

the project will be described. Based on these weakness control mechanisms and governance factors to prevent potential failure, or support the success will be suggested.

So overall when viewing this model from the perspective of 'Project ARA', Figure 3[15] should provide an overview of the model used to determine the success of failure of a project.

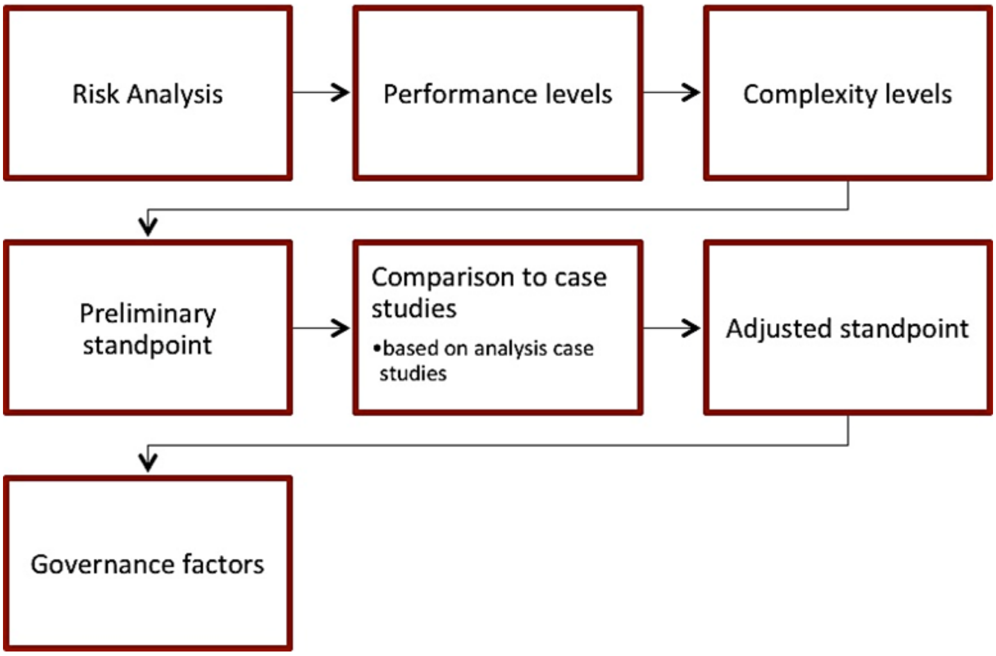

Figure 3: Model used to determine the outcome of a project (Aller, 2015/16)

[15] (Aller, 2015/16)

3. Methodology

The methodology applied throughout this work is easiest split into six different steps, as shown in Figure 4[16] that rely on each other. Most typically the project would first be preliminarily classified, according to the available data.

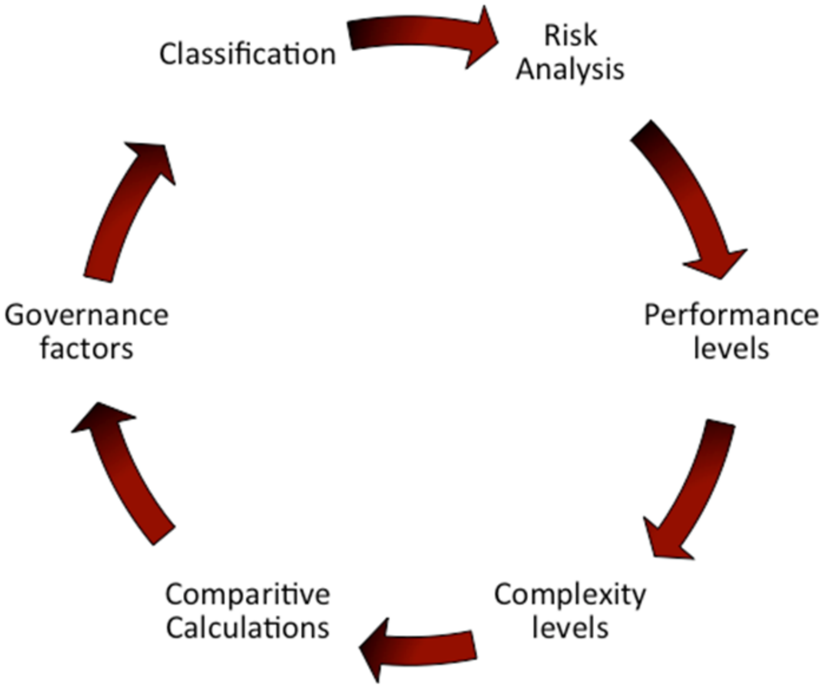

Figure 4: Application of methodology (Aller, 2015/16)

This is followed by a closer look of the performance and complexity levels of the project itself. Eventually this data is compiled and compared to other case studies. From this according to the weaknesses, governance factors will be suggested.

3.1. Classification of a project

Projects can be defined as complex, non-routine and one-time efforts.[17] They are limited by time, budget, resources and performance specifications that are designed to meet customer needs. Managing these projects includes the specific use of a set of tools, techniques and knowledge that when applied help to achieve the three main constraints of scope, cost and time.

The latest statistics state that 52,7% of all projects either take longer or cost more than the initially projected calculations. Most projects can be classified into three resolution types.

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[16] (Aller, 2015/16)
[17] (Attarzadeh & Ow, 2008)

‘Type 1’ outlines all successful projects. Characteristics include that they are completed on time, within the budget and fulfil all functions and features that were specified. Challenged projects are defined as ‘Type 2’. Even though projects are completed, they usually exceed the budget or the time frame, offering fewer functions and features than originally specified. The third type is defined as impaired projects. These are cancelled at some point during the development cycle.

3.2. Risk analysis

Risks are real or virtual occurrences that have a negative impact on the duration, the cost or the quality of a project or product. Every mathematical risk has a certain amount of chance (%) to either occur or not to occur. The goal of a risk analysis is to determine the chance with which each risk will occur. This process is bases its calculations on the schedule, goal projections and the stakeholder analysis[18]. Figure 5[19] depicts this four-step process, which is initiated with the risk identification. This continuous on to a throughout assessment of the identified risk, which are collected in a risk portfolio or risk log. These risk are then, either avoided, reduced, offloaded or accepted as rest risk in the next step of risk control. The final step concludes in calculating the damage produced.

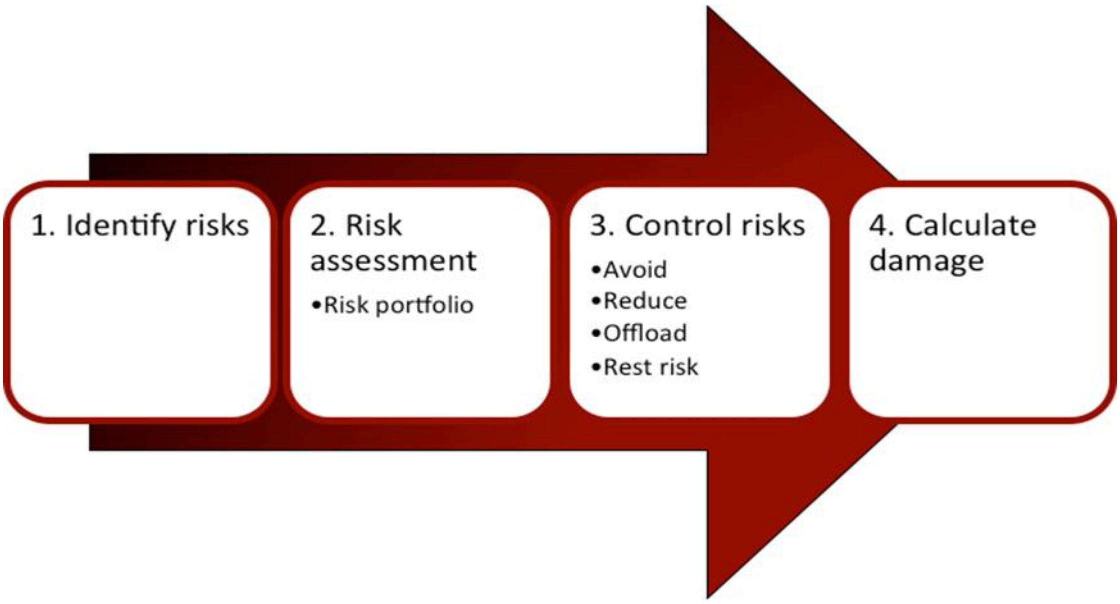

Figure 5: Steps of a risk analysis (Aller, 2015/16)

This process of risk management is based on the source (Projektmanagement Manufaktur), which inspired Figure 5. Only the most vital parts that could be applied without detailed

[18] (Projektmanagement Manufaktur)
[19] (Aller, 2015/16)

knowledge of the case studies were chosen and assessed according to specific criteria. Based on the concepts, further complexity was developed and scaling methods created. Both theory and partial insight from the source were applied in order to build a comprehensive method that would support the determination of a project's outcome by analysing initial risks. This will then support the further implemented methodology

3.2.1. Identification of risks

The first part of risk management is establishing a risk overview where all potential risks: external risks, internal risks, planning risks and risks associated with business, technical and environmental issues are categorized. Typically, key team members and stakeholders of the project are questioned. This provides a general overview on the most dominant risks. Often subject experts are consulted to analyse the current project status to determine the potential for future problems and the risks associated with them. For further insight, the quality of data has to be continuously checked and an onsite analysis can provide further helpful data.

One risk group[20] is identified as external risks. Here factors such as political regulations and interest control the environment and process behind the project. Both sub categories may impose severe restrictions on the project. The environmental sub-category includes factors such as weather, in terms of possible disadvantages for outside venues or sites and economic problems that might impact on transportation, the cost of project or space availability.

Another risk group is identified as internal risk. This includes the resource application, which if done improperly can lead to shortages or resulting costs when miscalculated. Technical risks have become increasingly important in modern projects. For example, a lack of technical equipment can impact the effectiveness of the team and cause severe delays.

The third risk group is stated as business risks. Here the skills and work quality of the marketing, financing and management team are taken into consideration. If aspects of their work, such as the marketing tasks of market research are faulty, the project is deprived of a proper approach. If initial data is false, subsequent steps are bound to be faulty. This can be seen in financial key tasks such as budgeting, financing and capital investment. If any of the

[20] (Projektmanagement Manufaktur)

preceding factors are miscalculated the project will either run out of financial resource, or undermine their potential if more budget would have been available.

Another type of risk is the risk associated with planning. The areas scheduling, human resource management and quality control are the main focus. Accurate scheduling is necessary so that the project is completed in time and tasks that depend on each other are executed in a given time frame. The distribution of human resources is also important so that the duration, difficulty and skill requirements per tasks are well matched. Quality control is perhaps the most important task and helps to guarantee a high quality of any given project and meet the stakeholder's demands.

The final risk group that has to be considered are the environmental risks. This group is usually made of external stakeholders that are interested in protecting animal and environmental rights and work in their favour. This can result in protests that may delay the scheduling of the project.

3.2.2. Risk assessment

Every risk is then logged with a risk score in the portfolio, depending on the effect it will have on the project's outcome. Each logged risk will receive a risk score and undergo the process of risk assessment. For this a scale depicted in **Figure 6**[21] is generally used.

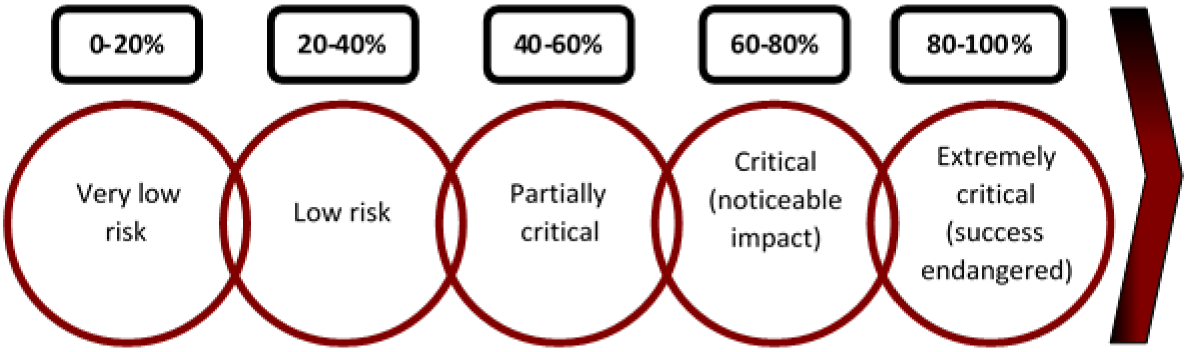

Figure 6: Risk assessment, severity spread (Aller, 2015/16) (Projektmanagement Manufaktur)

The risk assessment team or specialists[22] that are well informed on the project usually choose the severity of the risk. They should be able to combine current knowledge and past knowledge to determine the likelihood of occurrence and the potential impact. The higher the risk is labelled the more critical it is to control the problem and find a solution. A high

[21] (Projektmanagement Manufaktur) (Aller, 2015/16)

percentage assigned to a risk identifies with endangering the project's success, while a low assigned percentage normally has minimal impact on the project's outcome. In order to keep track of these various risk groups and potential threats to the project's success, risk logs are filed.

Figure 7[23] shows the typical variables a risk log might include. The key components are statistics and descriptors of the risk and an analysis of the impact and various prevention or alternative methods.

Risk ID	Description	Effect/ Result	Contact person	Status	Plan B	% of occurrence	Indicator of occurrence	Risk Score	Estimated damage

Figure 7: Example of a risk log (Projektmanagement Manufaktur)

3.2.3. Controlling risks

There are four options that management can decide upon once the risks have been identified.[24] These options are avoiding, reducing, offloading or acceptance of the rest risk. Depending on the resulting percentage derived from the risk assessment step the control measures vary. Additionally, the main aspects of quality, time and cost are key determining factors on the resulting choices. According to this, solution methods to handle the risks are initiated in the control process. Often the key term members will provide possible short-term solutions.

The first and preferred step is avoiding the risk. All risks are potential candidates for this category. If management chooses this option, planning skills have to be very specific and additional time is required, so that the critical path of a project is not affected. Choosing this option comes with many advantages, the outcome generally doesn't lack in quality and is likely to be completed in time. Here the main focus is on finishing the tasks, while extending the planned time, without impacting the overall time frame or critical path. This solely means that the earliest starting time of the following tasks is pushed back and the earliest finishing time of the problematic task is moved back. Additional costs may result, since the

[23] (Projektmanagement Manufaktur)
[24] (Projektmanagement Manufaktur)

planned resources assigned to the task are occupied not only for the shortest completion time, but also longer.

If the problem cannot be solved through avoidance the second option comes into play. The second option is used when the latest finish time of the problematic task draws critically close and the potential of the problem reaching a higher risk level is present. By reassigning resources for a certain time period from one task to another, management aims to reduce the impact. If additional resources, either in the form of material, human or facilities, need to be assigned, the cost is likely to be higher and resources could be diverted from other tasks. If resource distribution is not carefully planned and calculated this solution might turn into a problem itself. Due to a lack in skilled resources, or slack time to complete the tasks the quality of the project might be affected.

The next level of control is initiated when the risk cannot be reduced using the project's resources. This method of control uses offloading as a solution, where the workload is handed off to a third party. Especially in projects that handle sensitive information this method can be problematic. Not only does the quality of the project decrease, due to a variation in the method of completing the task, but also with different resources the brand quality cannot be guaranteed. Additionally, the cost of buying resources, human, machine and materials, lowers the budget for other tasks. The time factor is also another disadvantage since the time until completion, especially for critical activities is extended and the starting point of other activities might be pushed back.

If none of the previously explored methods can cope as a solution, the impact needs to be accepted. This is only done for low risk tasks that do not affect the project's outcome directly. This includes all tasks with a risk score of up to 40%. As long as no other critical tasks are affected, the failure of these tasks may reflect a lack of scheduling skill, distribution of resources, budgeting or general management flaws. The most dominant impact of this method is that resources, money and time will have been spent without any result, resulting in the potential lack of the above named for other tasks.

3.2.4. Calculate damage

Depending on the method the damage will vary. Avoiding the risk will result in the least damage, and accepting the impact in the most damage.[25] In this part of the risk analysis, the

[25] (Projektmanagement Manufaktur)

financial damage of the risk control is calculated and documented in order to convey the information to the budgeting and finance team. This could then lead to further control measurements in case of budgeting shortages, or in seldom cases the availability of budget and resources from cancelled tasks. From this the damage is calculated, which is then passed on to management and finance in order to address the project's budget and resource availability and adjust accordingly.

3.3. Performance monitoring

Throughout a project, monitoring various management areas can help to identify performance levels and discover areas of concern, finding respective solutions in time. Figure 8[26] attempts to scale the various performance levels and provide an overview of weaknesses and areas of improvement the project could benefit from if addressed.[27]

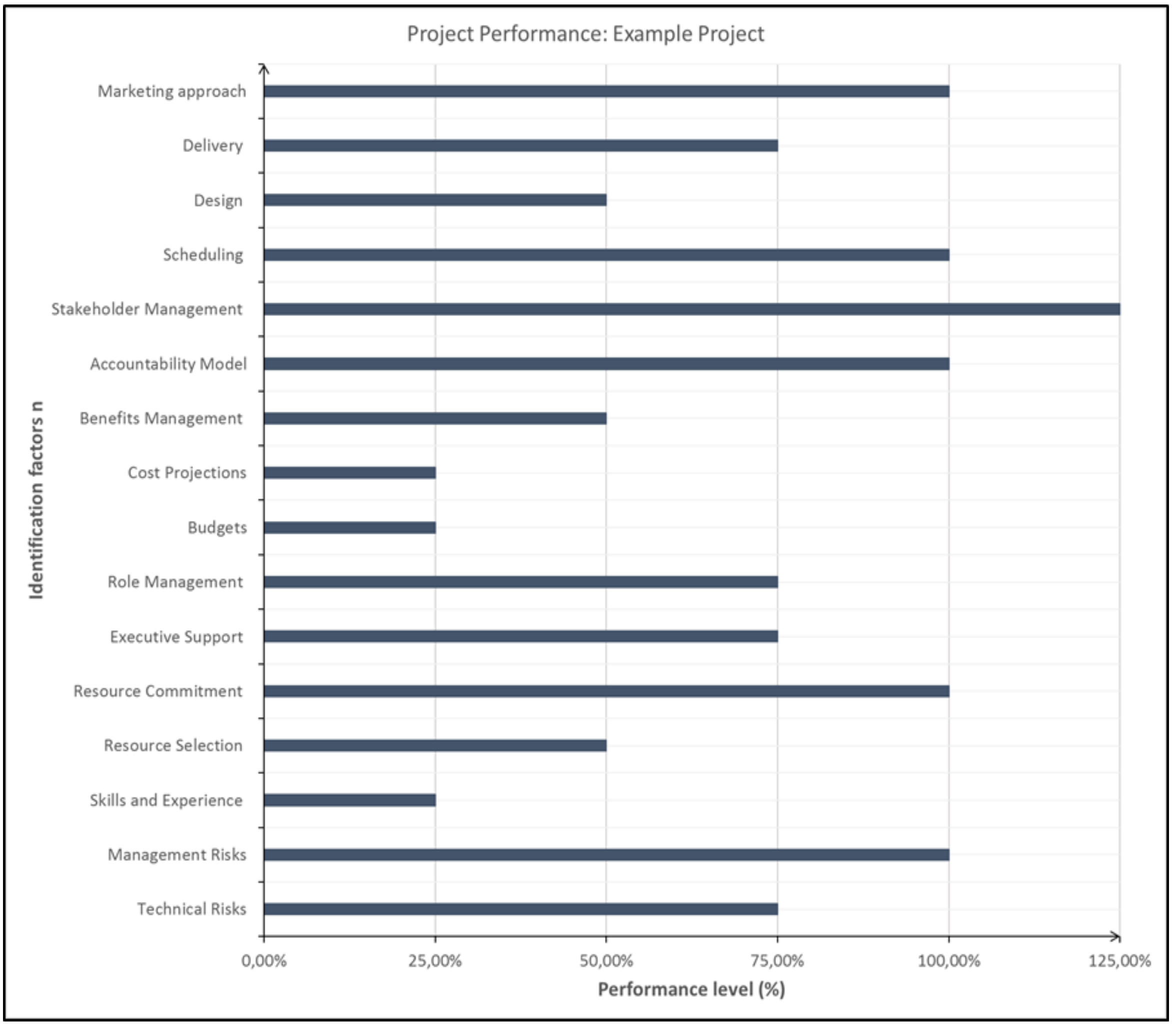

Figure 8: Project performance example graph (Aller, 2015/16) (Su, March 27th 2013, S. 19)

[26] (Aller, 2015/16)
[27] (Su, March 27th 2013)

The project performance graph is based on a method commonly used by Deloitte (Su, March 27th 2013). In their analysis of a project's performance there are a few more criteria. In order to apply this to this bachelor thesis, where exact numbers and figures of detailed project knowledge are scarce a few criteria were removed and the criteria 'marketing approach' was added. Since the initial approach was quite complex, Figure 8 is a shortened version that is more effective for these case studies. The following explanation will be a mixture between Deloitte's applied theory and practical methodology and adjustments made by the author of this paper.

The performance level is divided in various performance levels. Everything up to 50% falls into the category: 'of concern', where work is required and the current management is not effective enough. 50 to 75% are underperforming, with more potential to grow. At 75 to 100% the performance level falls under expected acceptable range for success. 100 to 125% show an over performance potential over investment in the specific area. An average line will outline the actual performance level average across all categories.

Risk management focuses on the areas technical risks, the general management of these risks. As discussed above the performance level and the monitoring of the success this area has is vital in guaranteeing a smooth risk control process. A delay of the project, unexpected expenses and a reduced quality, reflect low performance in risk management. Recognizing and preventing potential problems can achieve a high performance. With modernization of processes technical risks need to be considered especially and addressed directly, so that the impact is minimized. Many processes depend on technology and a deficit in this area will have drastic results on the success of the project.

Another area of interest is resource management, which includes skills and experience, resource selection and commitment. The careful planning and assigning of resources is necessary for processes to be completed in a timely fashion and the respective quality level. The amount of resources, human and material has to be available in the right quantities and at the right locations. A deficit in either quality or availability can cause a delay on the critical path tasks of a project and may cause its failure. Human resources especially have to addressed according to skills and experience and have to be available at the right place, in the right position and at the right time, in order to reach the maximum performance levels.

The third monitored area is ownership, which describes the amount of executive support. Here communication between management and executives is crucial to meet the standards and goals of a project. Constant updates, information sharing and feedback are a large part of creating a project according to stakeholder wants. If criteria set forth by management are not met or the client's wishes are not fulfilled, the relationship and image of the organizers is weakened and future clientele might be more suspicious and willing to pay less for the services.

The governance area monitors role and benefits management, the budgets and the accountability model. Depending on the nature of the company and project, extra work or special engagement might be rewarded and result in higher motivation levels of the workers. Traditionally roles are distributed in a clear organizational chart, but more modern approaches split tasks and work titles across disciplines and areas of knowledge, making communication more difficult. How this is governed and who holds accountability also influences worker's reactions and engagement. The correct calculation of the budget is vital for allowing maximum application to resource usage. Any miscalculations will disrupt the workflow and increase the workload for management.

The next area of focus is delivery management. This includes scheduling, marketing approach, design and delivery. If a project follows the timetable, with the parallel scheduling plan for resources and tasks the overall execution should proceed smoothly. The success of design and delivery are a direct reflection of a successful working process and outcome. Both categories are closely linked to resource management and the supply of named resources. Finally, the marketing approach, when effective can be a huge support factor for the success of a project or product.

Overall the performance level will provide an overview of the strengths and key drivers of a project's success, but also highlight low performance areas that support failure. By assessing the various areas of a project, the many aspects that play into a project's outcome are taken into account. According to the later discussed method, these areas can then be governed, through which the average project performance might be increased.

3.4. Complexity assessment

When trying maintaining the quality, timeline and success possibility of a project, the complexity of the project can be a determining factor of the amount of control needed. Here the theory is taken from Deloitte's process (Su, March 27th 2013, S. 15). The scoring method was developed and interpreted by the author, using a spider diagram model to convey the data. The following explanation will again contain a mixture of interpretation and application of the initial source in order to derive a method best suited for the case studies in this work.

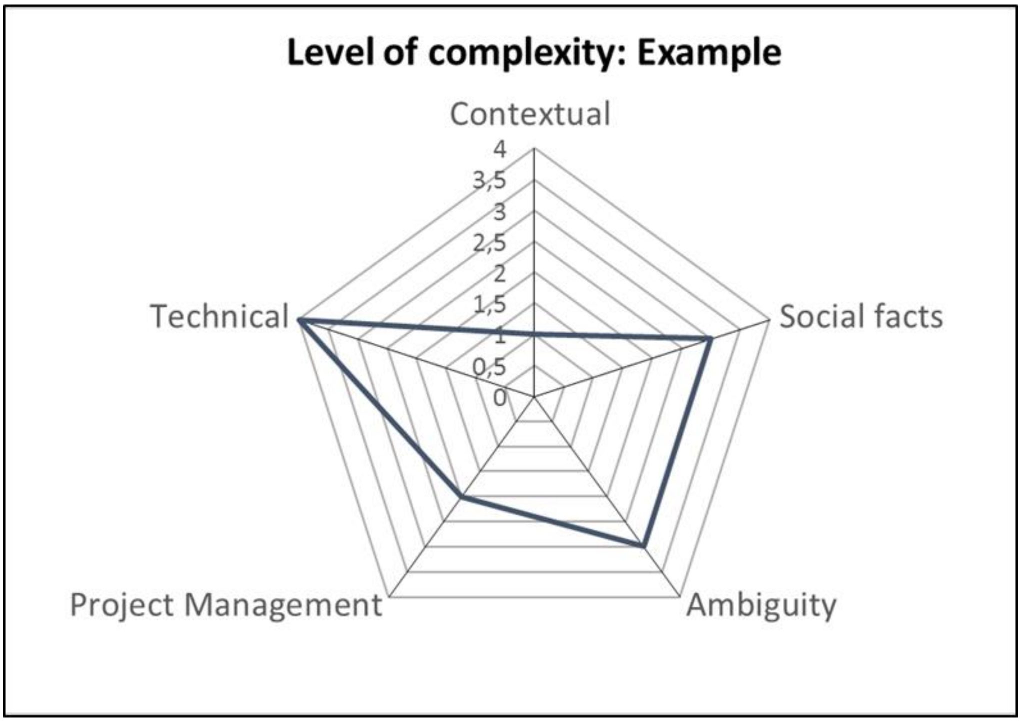

Figure 9: Example of spider diagram for complexity assessment (Aller, 2015/16)

There are five factors, identified in Figure 9[28], which have the most impact on the complexity levels. [29]Technical, social and contextual complexity, ambiguity and project management are the main contributors. The higher the complexity of a project, the higher the level of precision, control and feedback in management work and between key decision makers, is required. If this is not the case, and the project is handled careless the probability for the success of the project decreases drastically.

Contextual complexity is generally driven by the stakeholder's actions. More specifically, this includes the amount of stakeholder groups and the power that they hold over the projects process. If complexity levels are high, which is expressed though a high number of

[28] (Aller, 2015/16)
[29] (Su, March 27th 2013)

stakeholder groups, and a lack of independent actions by management, the project can suffer immensely. Not only do decisions generally take longer, but a high controlling interest can also lead to forced decisions that stakeholders, with low insight into the project operations, make, but do not necessarily aid in the project's success. Here it is important that higher management stands in a constant feedback loop with stakeholder, so that new concepts and ideas or changes in structure and timeframe of the project can be identified early on. This can take weight off the potential negative impacts.

Another factor, which influences the overall complexity levels of a project, is the technical complexity. This is defined as the impact technology has on the infrastructure of the project, to what extend technical concepts and features are integrated and how complex data systems are. Generally speaking, technology has led to many improvements in terms of efficiency levels to document and share information. These issues arise from a lack of maintaining the databases and the continuous data entry process. Older generations especially face problems comprehending new and complex systems, when compared to younger generations that were exposed to similar systems their entire life. Here again management needs to carefully that all data is up to date so that potential problems can be identified early on.

Social facts play one of the main roles in the complexity of a project. Here the ability and extent of cross discipline familiarity, multi-disciplinary and the levels of change throughout the organization are identifying qualities. In this case a broad knowledge can aid in the potential replacement of absent key members of a team. Since a project is typically restricted in its time frame, the absence of experts can prevent important bottleneck activities from being completed. Here it is crucial that team members are trained in a way that they become expendable, or replaceable resources if necessary, so the timeline is not impaired. High levels of change throughout an organization can create high levels of inconsistency and potential stress, therefore it is important that these are minimized and employees learn to adapt to constant change and can react in a flexible manner if necessary. Human resource planning must address all possible scenarios and anticipate changes, absences and necessary additions.

The ambiguity of a project deals with the uncertainties, assumptions and estimations that are made in a project's plan by management functions. The more speculations and non-specific measures, facts and durations are used in calculations to determine factors that influence decisions, the higher the complexity of the project is. Straightforward facts and true measures and estimations aid in making management decisions on additional resources, material or human capacities. With more speculation this process becomes more complex and less precise. Therefore, these estimations should be reduced as much as possible. With higher risk factors, the complexity of the project increases, because preventive measures in case of failure have to be anticipated and a lot more materials have to be accessible in a shorter time period. Overall the amount of management control needed increased drastically.

The perhaps largest factor that determines the complexity of a project is the management process. Many factors such as the scope of the project structure, the nature of the team, in terms of size and experience, the availability of resources and financial expenditure, are important in this area. Another aspect is the timeframe and scheduling, which also determines the flexibility of a project. The management decisions and methods can themselves have a major impact on the overall complexity of the project. If the team is unfamiliar with the techniques or the methods aren't controlled or applied in an orderly fashion, the complexity of the project increases. The team's quality is directly reflected through the management and the project itself. The more in tune they are, the smoother the work will reach completion. With experience knowledge and possibly a more independent working style are developed. An inexperienced team of a larger size will add to the complexity of a project, since much more introductory tasks and control over the team have to be applied. A similar concept can be applied to the schedule and timeframe. Without a clear structure and overview based on careful planning, unnecessary complexity can be added.

As a closing statement it can be said that the many factors that flow into the complexity of a project, direct the managerial aspects throughout a project. Therefore, it is vital that they are considered when scheduling, planning and completing everyday tasks. Ignorance towards the subject matter could have devastating impacts and will generally support unrealistic expectations of the team or the project's outcome and completion time, quality and cost.

3.5. Comparative calculations

The final step of determining the success or failure of a project comes down to comparing case study data. Even though the four projects analysed in this thesis only give a limited argumentation point, a basic point of comparison will be created. This will provide key indicators for the direction a project is most likely to take, success or failure. Three levels of qqâ1ycomparison will be applied: comparing the performance levels, comparing the various areas of complexity and the overall complexity and finally graphing performance against complexity.

3.5.1. Performance level comparison

The first comparative measure is the average performance of the individual projects graphed in a bar chart as portrayed in Figure 10.[30] The author developed this measures as a mean of comparing the case studies and determine indication factors of a project's outcome.

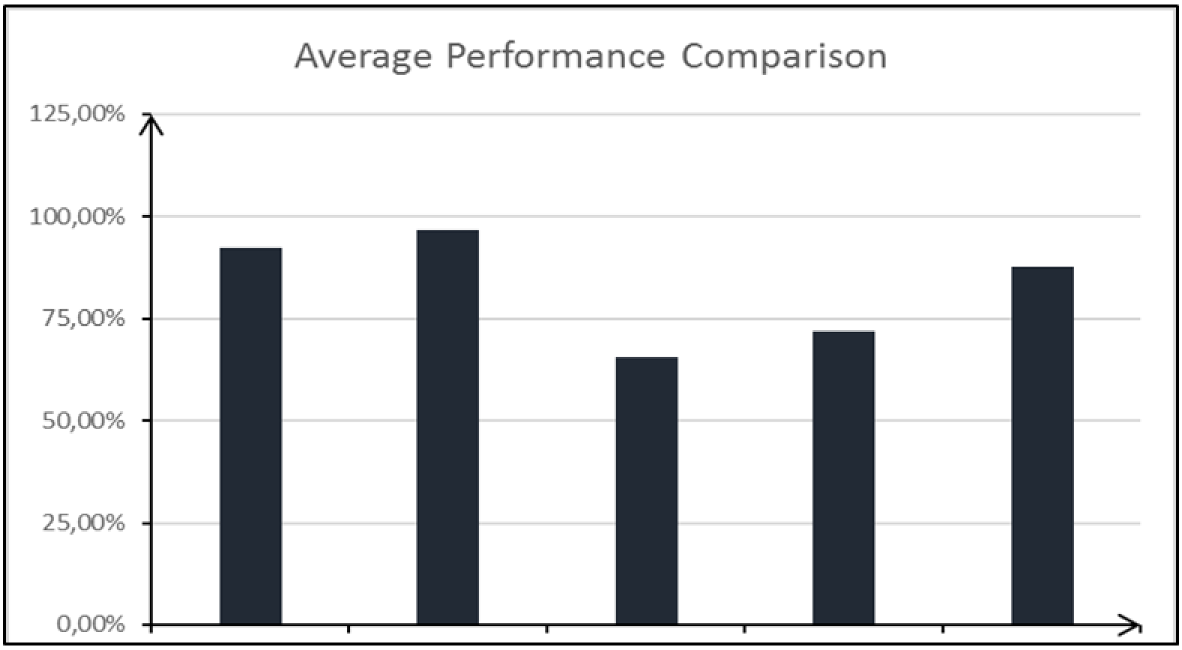

Figure 10: Example of bar chart for graphing the average project performance (Aller, 2015/16)

The goal is to find similar and contradicting data between the successful and the failed projects. From this it will then be easier to determine how the performance percentage of 'Project ARA' lies, and how this could predict the outcome.

After the average performance has been compared, the comparison will go into further detail, comparing 'Project ARA' data to the successful case study data and the failed case

[30] (Aller, 2015/16)

study data separately. This will help find similarities in the criteria that might indicate the success or failure of ‘Project ARA’.

These could be considered determinants that might be decisive and can provide data for governance factors for management. Figure 11[31] shows a method commonly applied by Deloitte when assessing a project’s outcome. Depending on how many characteristics are shared with the successful or failed projects, the outcome of the project can become even clearer. The comparison of the project’s percentages by criteria was undertaken in the comparative part. Comparing each criterion individually gives an indication of criteria’s indicating success and those reflecting failure.

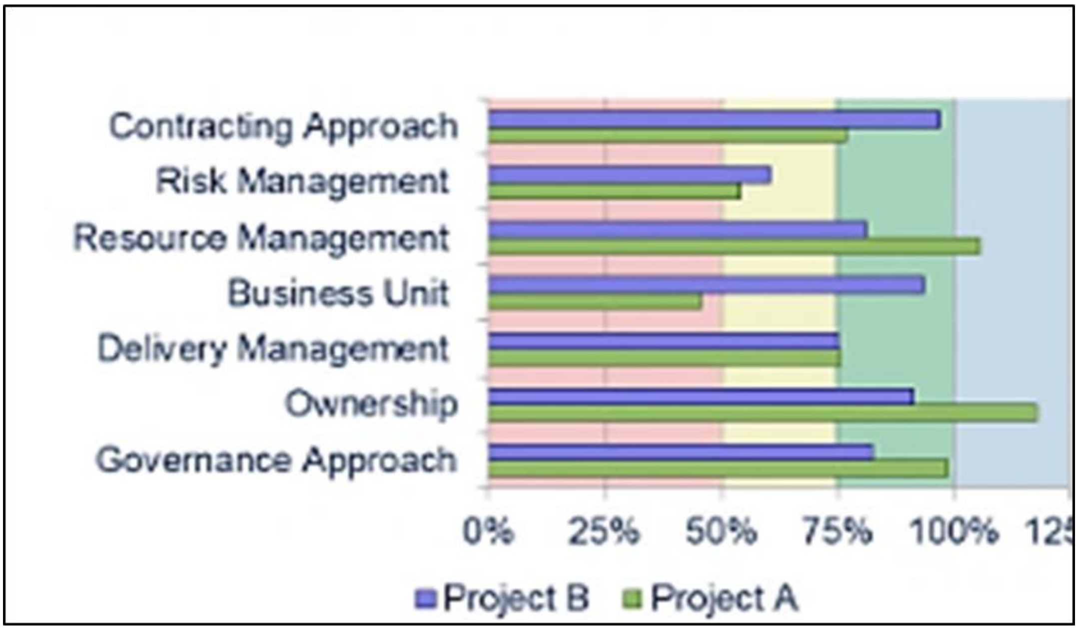

Figure 11: Example of project performance comparison (Su, March 27th 2013, S. 22)

[31] (Su, March 27th 2013)

3.5.2. Complexity level comparison

The next method compares the complexity levels of the project, scrutinizing each individual factor that can contribute to the overall level of complexity. **Figure 12**[32], gives an indication of the final graph. This was developed by the author, combining both the total complexity score and the score in each criterion. Again similarities and differences can be drawn from the graph, predicting success or failing determinations.

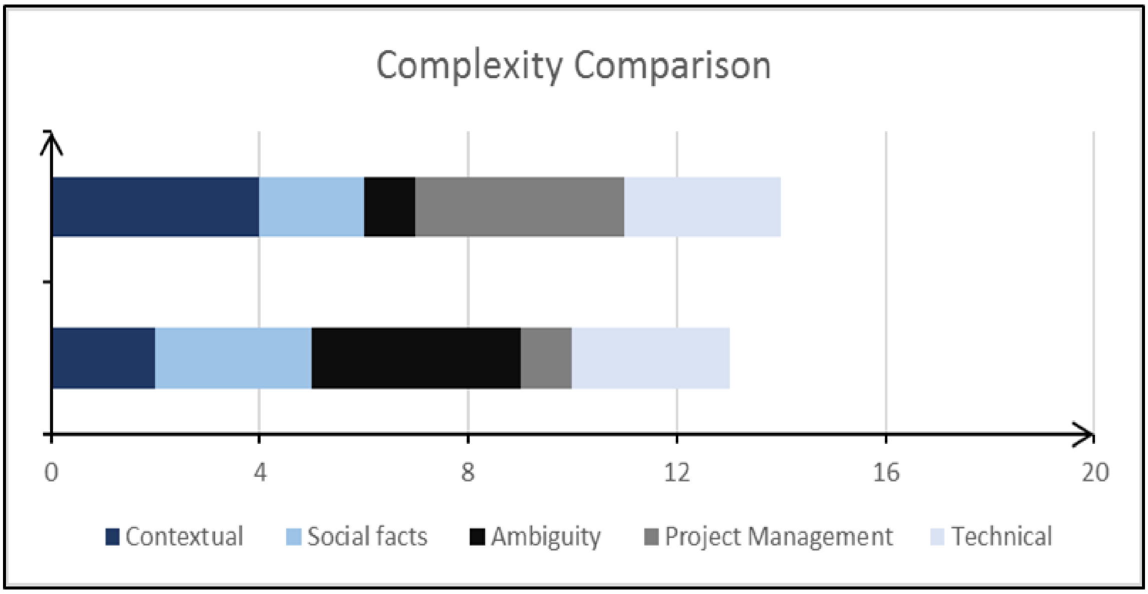

Figure 12: Example of a bar chart, graphing the complexity comparatively (Aller, 2015/16)

Not only does it allow the observer to gain insight into the five categories, but also the overall score. From this the most complex areas that require the most amount of managerial control can be identified. If projects share similar complexity levels, the outcomes or at least the general process will overlap. This will provide an estimate of the overall outcome of the project.

[32] (Aller, 2015/16)

3.5.3. Performance against complexity – Graph

In the last comparative method, the average performance levels will be graphed against the complexity levels. This data will be graphed on a scatter plot graph, from which an approximate trend line can be drawn. Ideally, with more comparative projects this could look like the Deloitte example in Figure 13[33]. The comparative approach to determining project outcome commonly applied by Deloitte has been copied with a slight alterations and the problem of only possessing five points of data. Through the plotting a complexity against performance criteria, it is made possible to determine the performance required at a certain complexity. Additionally, it can therefore predict whether performance levels of a project are high enough for the existing complexity and what performance levels were required.

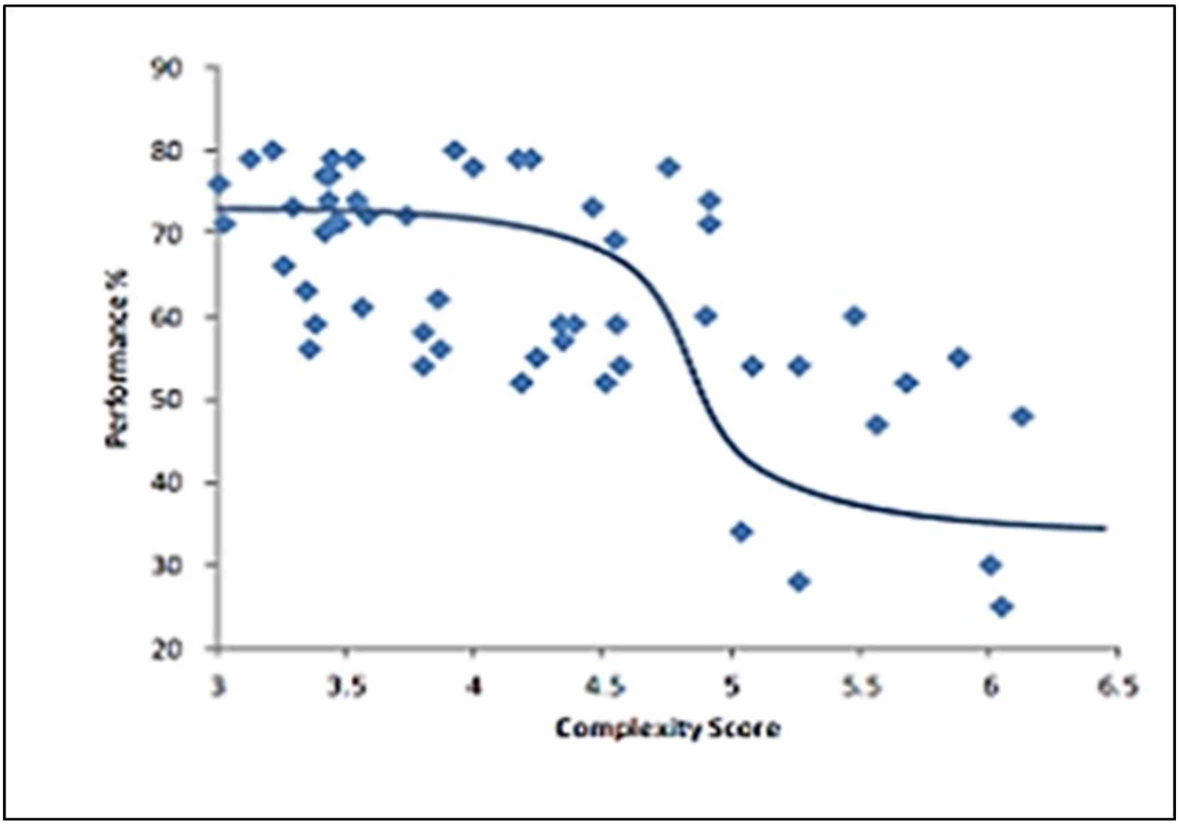

Figure 13: Scatter plot graph, x-complexity score against y-performance % (Su, March 27th 2013, S. 22)

The calculated trend line, which will be inaccurate due to the only four existing points for comparison, the final project will be plotted. Depending on the coordinates the similarities to the case study outcomes can be determined. By following general indicators of the trend line, analytical conclusions can be drawn providing an approximation of the project outcome.

[33] (Su, March 27th 2013)

The conclusion is based on all comparative measures, and will try to pinpoint the areas that are crucial for the success of a project, or what scenarios are most plausible.

3.6. Governance factors

The main areas that governance factors are applied to are resource and delivery management, ownership, governance, contracting and the business unit itself. In order to pre-vent projects from failing over time many preventative methods have been developed. In every project key governance groups provide additional support. Monitoring of a company's internal and external activities and the risks associated with them is done through various key governance support groups, indicated in Figure 14.[34]

Figure 14: Governance factors in business (Su, March 27th 2013)

The internal audit is part of the first monitoring group, where key risks the company faces are identified and corresponding solutions or prevention methods are identified.[35] The main goal is to guarantee the organisation's objectives. While the internal audit looks at both financial and non-financial aspects, the external audit analyses only the financial side. The annual review of financial accounts and internal financial control methods pro-vide an

[34] (Su, March 27th 2013)
[35] (Turnkey Consulting)

estimate of the company's financial position. The collected data is then presented through the audit committee, which relies on its independence from management control.[36]

The next area of control is risk management, where risks are first identified, analysed, assessed and then either avoided, reduced, offloaded or accepted as rest risk.[37] Project management, which is defined as the application of knowledge, skills, tools, and techniques to activities in order to meet certain requirements. This becomes another vital monitoring source.[38]

The third governance support group consists of senior management and the board of directors. The senior management, typically appointed by the board of directors, actively participates in the daily supervision, planning and administrative processes, with the objective of reaching company goals.[39] Above the senior management, the elected board of directors operates mainly representing the stockholders, establishing corporate policies and deciding on major company issues.[40]

Through governments and other regulators, another monitoring group is added to the progress of a project. This is normally expressed through corporate laws, taxes and other laws that influence the way that a business can operate.[41] Program governance on the other hand ensures an alignment between business strategy and the goals throughout a program's life cycle.[42]

The referenced key governance factors control much of the process surrounding a project and the actions of the company. Not only does the financial and non-financial data of the organization provide insight into the company's power and possibilities, but also helps recognize key risks and helps prevent them. Furthermore, the daily processes are planned and supervised and solutions for company issues are outlined. The actions are further controlled through government and official regulations. Each group will limit or improve the quality of everyday tasks.

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[36] (Financial Times)
[37] (Business Dictionary)
[38] (Project Management Institute Inc., 2010)
[39] (Business Dictionary)
[40] (Investopedia)
[41] (Cambridge Business English Dictionary)
[42] (Hanford, 2005)

4. 'Project ARA'

For the analysis of 'Project ARA' there are four steps that will be followed. To provide an outline of the facts and figures of the project, the development of the project, the current status of the team, the general goal and the disadvantages will be described in the introduction. This is followed by the identification of potential risks associated with the project, their assessment and the control measures. After this the performance and complexity levels are assessed.

4.1. Introduction

'Project ARA' is based on the modular phone concept by the Dutch Designer Cave Hakkens. In a YouTube video[43] that went viral on the 10th September 2013 he first introduced this idea. He imagined the collaborative work of scientists, developers and companies via an open platform to create a 'phone worth keeping'.

From this 'Phonebloks'[44] was introduced as a solution to the continuously increasing amount of electronic waste we produce, to which phones are one of the biggest contributors. Every time one component of the smartphone malfunctions or becomes out-dated, it is thrown away, even if the rest of the phone is still operable. Companies do not strive to create long lasting electronics or produce little waste material; their focus lies in high profits, without taking the resulting consequences into consideration. Hakkens wanted

[43] (Hakkens, Phonebloks - The ultimate phone concept, 12th Sept 2013)
[44] (Hakkens, Phonebloks, 2013)

to reduce this excess waste, by creating a phone that was put together with interchangeable blocks. This meant that one block could easily be replaced if it malfunctioned or became out-dated. All blocks would be connected to a base by pins that could transfer signals; two screws would then hold all parts in place. Through this the customer would be provided with the option of customizing their phone. Not only would the brand be variable, but also the quality and type of feature, such as better cameras or longer lasting batteries.

4.1.1. Facts and figures – 'Project ARA'

[45]Based on this concept in November 2013 a research team was formed. This combined DARPA workers that pursue futuristic projects and Google's advanced technology & knowledge product group.[46] The final team consists of 20 partners, and ads up to 150 people.[47] In collaboration with universities across the globe a nonlinear working style was adapted through which interdisciplinary work with cooperate trade-offs and cooperative efforts were possible. This small team used basic scientific and technical understanding and new physic discoveries and technology to develop a modular phone.

Figure 15: 'Project ARA' logo (Project ARA)

After team ARA developed the endoskeletal hardware, developers were attracted to create basic modules, which is an essential step for the following project steps. Distributing the MDK, the module developer's kit[48], which contained: design specifications, open source firm- and hardware, a set of designed electrical and mechanical cap modules, became the first step of marketing. These kits enabled partners to develop modules from scratch, and either utilize contract manufacturing and module design services to complete their concepts, or create their own modules. Additionally, several 100 sets of developer hardware or death boards were loaned out so that the creation of prototypes and the testing of modules would be more efficient and affordable for smaller partners.

In order to test the consumer reaction to this product, Puerto Rico was chosen as a pilot market.[49] With about 3 million in population, this country accommodates a very diverse mobile user base, form entry-level feature phones to premium smart phones. This reflects

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[45] (Project ARA)
[46] (The Verge, 2014)
[47] (Eremenko, Google's Project Ara Prototype Demo, 2015)
[48] (Project ARA) (Eremenko, Project ARA DevCon2 Highlights, 2015)
[49] (Eremenko, Project ARA DevCon2 Highlights, 2015)

the respective global market shares: 1,5 billion smart phone and 5 billion feature phone users. Puerto Ricans are veracious mobile users: ¾ of all Internet access is conducted with mobile devices, reflecting a global trend. Field experimentation and analyses were implemented, resulting in case-specific information and feedback that would shape the product according to the needs of the community. The University of Puerto Rico, including all eleven campuses, posed as a controlled environment for research. They later become a member of the multi university research agreement, MURA.

Puerto Rico is in American territory and under FCC jurisdiction[50], allowing a regulatory approach for certifying ARA. This provides an advantage to speed up the product launch since political and legal discrepancies are limited. Being a designated free trade zone, the import of modules from developers worldwide was an easy task as well.

Part of 'Project ARA' was the implementation of a logistic infrastructure, needed to receive endoskeletons, shells and modules from platform partners. Aspects such as the maintenance of the inventory, the construction of additional manufacturing plants for the decoration of shells, via a di-supplementation process, and the specific customer packaging. Furthermore, the transportation means for packaging and shipping to customers and retail points, had to be arranged. The trucks are designed to provide constant feedback of their routes, in order to tailor the pilot project according to additional requirements and collect marketing information on less profitable areas.

Through a close collaboration with the distributive carries Open Mobile and Claro Puerto Rico, a tailored carrier acceptance protocol for ARA cellular modules and devices can be created. Additionally, joint retail opportunities and the development of a service module for the ARA market pilot are being explored.

4.1.2. Goals and disadvantages

The general goal of 'Project ARA' is to develop awareness to the environment, creating a more sustainable solution to constant updates in technology and the massive amounts of toxic wastes produced from cell phones.[51] By developing interchangeable modules, broken or out-dated parts can easily be replaced. Apart from being more environmentally friendly, the concept of individualization[52] can be pursued. Modular phones can be created according

[50] (Eremenko, Project ARA DevCon2 Highlights, 2015)
[51] (Hakkens, Phonebloks - The ultimate phone concept, 12th Sept 2013)
[52] (Eremenko, Project ARA DevCon2 Highlights, 2015)

to the individual's preferences. Each module can be chosen by brand, price and quality level. Even the shell casing can bare individualized pictures or designs.

Cell phones traditionally attempt to cover all features on one single circuit board or single chip, reducing the space and the components in this space. Modular phones on the other hand pull apart these features and place them on individual modules, rather promoting quality over quantity.[53] Even though this has a lot of benefits, it also comes with an enormous disadvantage, a generally thicker appearance and an increase in battery exhaustion.

This disadvantage is reduced to a penalty of ¼ in comparison with current smart phones. Consumers have to choose whether they are willing to trade individuality, flexibility and a more environmentally friendly position for the penalty of a thicker, less long lasting phone. The project sets completely new standards on how phones will evolve and how production and purchase will change in the future.

4.1.3. Development process

The latest version: Spiral 3, has undergone three development stages so far. The 'Phoneblok' concept was transformed into the prototype Spiral 1 version and then into the Spiral 2 model. The basic concept is an endoskeleton **Figure 16**[54] over which data between the attached modules is processed and transferred.

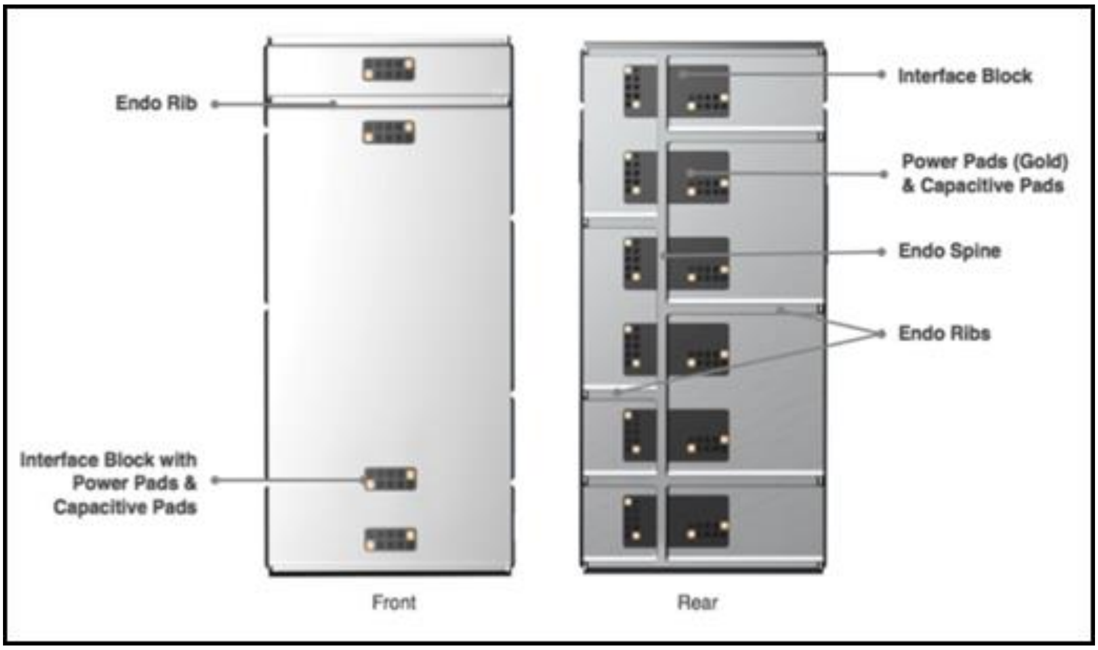

Figure 16: ARA Endoskeleton and structural components (Ara Endo (Medium Variant))

[53] (The Verge, 2014)
[54] (Ara Endo (Medium Variant))

On both sides of the endo-ribs, slots for the display and other modules are placed. Through next generation networking technology these interface blocks, more specifically pads and wireless capacitive pads, can be enabled. The high-speed interface technology runs on grey bus software, which supports a fast transfer of data between the modules. Electro permanent magnets are in control of holding the modules is place.[55] These are a cross between permanent and electro magnets, meaning they reside in an on and off state. Electrical pulses facilitate the regulation between the two states, allowing for hot swapping of modules without consuming any power. Hot swapping is the process of removing a model and replacing it with another, while leaving the device turned on. The new module with all its functions can be recognized after 10 seconds, ready for usage.

Proceeding to the modules that can be inserted into the endoskeleton. Various types include processors, speakers and batteries. The shells materials are moulded polycarbonates with a pebble like, waterproof exterior. The current software that the modules are compatible with is Android. For a more individualized shell, 3D printing of customized designs on the exterior is in a planning phase.[56]

4.1.3.1. Spiral 1

In June 2014 the Spiral 1 prototype[57] was presented, disproving the common concept that modular phones were impossible to produce. The application of the Moore's law, the slight change of the electro mechanical components and the application of a modern data protocol overcame major problems. The penalty on modularity was reduced to 25%, balancing the aspects of size, weight and power consumption, while supporting modularized features.

After only nine months after the implementation of 'Project ARA', the prototype was functional despite running over a laboratory bench. In this stage the main constricting features were resolved through implementing packet switch networks on the device. The industry standard Mipi UniPro protocol applies a flexible power bust, which allows the module to become a power source, power synch or power storage device. This is the technology necessary for hot swapping the battery and modules.

[55] (The Verge, 2014)
[56] (The Verge, 2014)
[57] (Eremenko, Google's Project Ara Prototype Demo, 2015)

At this stage[58], the creation of a supply chain for EPMs, electro permanent magnets, the process for the shell fabrication and the UniPro A6 are the main concern. 'Project ARA' claims, that by fall 2014, an android version that supports modularity will be ready to run on the software.

4.1.3.2. Spiral 2

In February 2015 the Spiral 2 Demo was introduced to the public.[59] This model uses a first generation UniPro Bridge and A6 switches that help communication between the AP and the display.[60] The shells are moulded polycarbonates with di-sublimations. The connector blocks embedded in the endo underwent a redesign switching to electro permanent magnets on both the front and the back.

Prototype modules such as a receiver module with an earpiece, audio and proximity sensor, a camera model with a higher megapixel camera, a Wi-Fi and Bluetooth module with integrated antenna and a display with attached volume and power buttons were designed. Others such as a band five antenna for 3G cellular receiver, and application processor based on marble chips, speaker and battery modules were also created for this version to give a perspective of 'Project ARA''s future.

In this stage, MDKs or module developer kits have been uploaded online, for potential producers of modules. In order to support this trend, more than 200 sets of developer hardware or death boards are loaned, in order to guide the creation and testing of prototypes.[61]

4.1.3.3. Spiral 3

With the introduction of the Spiral 3 prototype, multiple improvements to the Spiral 2 model were realized.[62] One new feature was changing the DC coupled data running over spring pins to AC coupled inductive pads between the endoskeleton and the modules. These inductive pads are contactless and have an air gap of 150 microns, which reduces the scratching produced from the older model's spring pins.

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[58] (Eremenko, Google's Project Ara Prototype Demo, 2015)
[59] (Desi Tribe, 2015)
[60] (Fishman, 2015)
[61] (Eremenko, Project ARA DevCon2 Highlights, 2015)
[62] (Eremenko, Project ARA DevCon2 Highlights, 2015)

Not only was the type of connection to the modules improved, but also its sturdiness, now being much more susceptible to heavy use or pressure. In the new design of the electro permanent magnets, they are embedded in the device's rear modules. The modules will allow double branding between 'Project ARA' and the brand of the modules.

4.2. Risk analysis

In order to complete a risk analysis on 'Project ARA' the Figure 5, Page16 model will be applied. For this the potential risks will have to be identified. The five groups[63], also identified earlier are external and internal risks, business risks, planning risks and the associated environmental risks.

The first risk group consists of all external risks. One of the impacts of political regulations could affect the later stages of the project, especially transportation, the establishment of storage facilities, manufacturing plants and the surrounding infrastructure to supply the product. With numerous restrictions solutions have to be found and the overall time will increase. Depending on the safety and construction rules, the calculated budget might have to be increased. Another external impact might be space availability in larger cities, when the product market is expanded to developed regions. Building a new manufacturing plant near a city or housing will be problematic and might lead to additional noise and pollution fees. Since the product is not ethically or otherwise negatively implicated, political restrictions might favour local producers more, but will not restrict the production or distribution of the product itself.

Internal risks are another group that one needs to assess, for optimal control of the project. This implicates the distribution of resources, more specifically material and human capacities. Since the team structure is extremely complex, the scheduling has to be on point. The potential risks include low effectiveness, if not all 150 team members are assigned specific tasks. The dependence on technical equipment is extremely high in this case, and any malfunctions or shortages could lead to immense delays. In this case one would have to plan for extra resources and financial support.

The third risk group, business risks, is reflected in the overall skills and expertise of the team. Here the sectors marketing, finance and management play a major role. In this case the skill level is very mixed, since professionals with extensive experience and universities with less

[63] (Projektmanagement Manufaktur)

experience and knowledgeable are included. Despite the fact that the more difficult engineering tasks and the final projections and choices are left to the experts, preliminary data has a high potential to be faulty. The risk is rooted in the initial data's accuracy, since subsequent steps have a high likelihood of being flawed.

Further risk factors come from planning. Scheduling, HRM and quality control, similar to the internal risks account for the potential risks. If too many tasks, or a too high workload is handed to an individual or given within a certain time frame, the possibility of it affecting and delaying other tasks is very high. This may lead to increased costs, if scheduling and human resources don't match up. Additional to the cost factor, the quality of the product might also suffer, if the planned time is too short.

The last potential risk group stems from environmental risks. In this case this risks are relatively low, since neither animal rights nor environmental rights are harmed. A point where this could become a problem, is when manufacturing plants at the latter stages of the project are being planned and built. In order to not delay the market entry and loose valuable production time, the potential risks need to be considered.

From this the following table was created, showcasing the level of risk, and the strategy to deal with them and the potential impacts.

Table 1: Risk analysis of 'Project ARA' (Aller, 2015/16)

Risk #	Risk group	Risk Name	Level of risk (%)	Control measure	Potential impact
1	External risk	Regulations on infrastructure, transport, manufacturing plants, storage	20%	Accept consequences	Time
2	External risk	Space availability, extra fees	40%	Accept consequences	Cost
3	External risk	Local business support	10%	Accept consequences	Cost
4	Internal risk	Effective scheduling	60%	Reduce, Offload	Cost, Time
5	Internal risk	Technical equipment	70%	Reduce, Offload	Cost, Time
6	Business risk	Skill level	70%	Reduce, Offload	Quality, Time
7	Planning risk	Task scheduling (quantity)	80%	Reduce, Offload	Quality, Cost, Time
8	Environmental risk	Manufacturing plant	20%	Plan with impact	Cost, Time

Table 1[64] gives an indication of the severity of risk factors associated with the project's success. As previously stated the level of risk determines the amount of managerial control necessary for each part of the risks.

To summarize the most dangerous risk in this project that falls into the category 'extremely critical' is risk no.7, the task scheduling. Since this project deals with a very complex team, a risk level of 80-100% reflects how vital it is for management to control the 150 official members, split between 20 partners. If some tasks lack the amount of human or material resources with the right qualifications, the schedule and completion date are endangered. If this is not monitored closely, the success of the project is threatened. Control measures for this include reducing the risk, by reassigning or increasing the number of available resources usually using the slack time assigned to a task. If this is not enough, tasks such as marketing research can be outsourced, by offloading the problem to a third party. The impact this category has on time can be severe, and can increase the costs through added resources. Additionally, outsourcing tasks can reduce the level of quality.

The next risk level is between 60-80%; any risk is considered critical and will have a noticeable impact on the success of the project. The risks that fall into this category are number 4, 5 and 6. The internal risks include effective scheduling and the problems associated with technical equipment. Effective scheduling includes assigning tasks, so that one individual has a manageable workload, with enough time for completion, and possible slack time. The technical equipment carries such a high importance, since a shortage or breakage of machinery will have immense impacts on the overall timeline of the project and in case of risk reduction or offloading will additionally drive up the cost. The third risk in this level is the skills and expertise the staff possesses. Despite the many experts working on 'ARA', there are also many groups that have less experience and knowledge, such as the universities. If in this case false or inaccurate data is provided by these parties and it would be used without double-checking, the quality of marketing application, product realization and many logistical aspects that rely on the gathered data would be of very low quality. The only measure that can again be applied is reduction of offloading.

[64] (Aller, 2015/16)

Another risk level includes risk estimated at 40-60%, which are partially critical. ‘Project ARA’ expresses these in through the risks, number 2 and 4. The more critical is the effective scheduling as an internal risk which links to the previously stated number 7, which falls into the level extremely critical. This risk is associated with the exact scheduling of resources, material and human, with the right skills, at the right time and in the right quantity. This risk can be dealt with by offloading or reducing and will most likely have a negative impact on the cost and time of the project. The other risk that falls into this level is the external risk associated with the space availability from a logistical standpoint. Here the consequences have to be accepted and are most likely to result in higher costs.

The second lowest risk level includes estimates from 20-40% and indicates a low risk level. The two identified risks from ‘Project ARA’ are number 1 and 8 from Figure X. The first risk is an external risk and includes certain regulations imposed by the government on infrastructure, transport, manufacturing plants or storage units. In terms of political restrictions there is very little that can be done, the application all required permits and licenses will potentially impact the time most. Number 8 is an environmental risk that could result from the risks based on the manufacturing plant or any other large, loud and potentially polluting set-up associated with ‘Project ARA’. In this case the potential impact has to be planned for and included in the research and execution of logistical tasks. If this is not done to the fullest, protests or legal restrictions will most probably delay the project and therefore directly impact the overall cost.

The lowest risk group that indicates a very low risk and minimal impact on the project ranges from 0 to 20%. This only includes one risk factor, number 3, an external risk depicted through the political favouritism and support of local businesses, either supported by laws or actions taken. In this case ‘Project ARA’ will have to accept the consequences and plan for a potential increase in costs due to higher prices for property, ground or additional fees that might arise.

Overall this results in a list of areas that require special monitoring support, especially in the higher risk categories of 60% upwards. This does not mean that the lower categories can be neglected but rather that due to their smaller impact on the overall project they are of less importance than the more critical risks, that require more attention.

4.3. Performance monitoring

The project performance tells a lot about the success of applying management control towards optimizing the process towards completion. This is summarized in the Appendix 9: Project performance level: 'Project ARA'.[65]

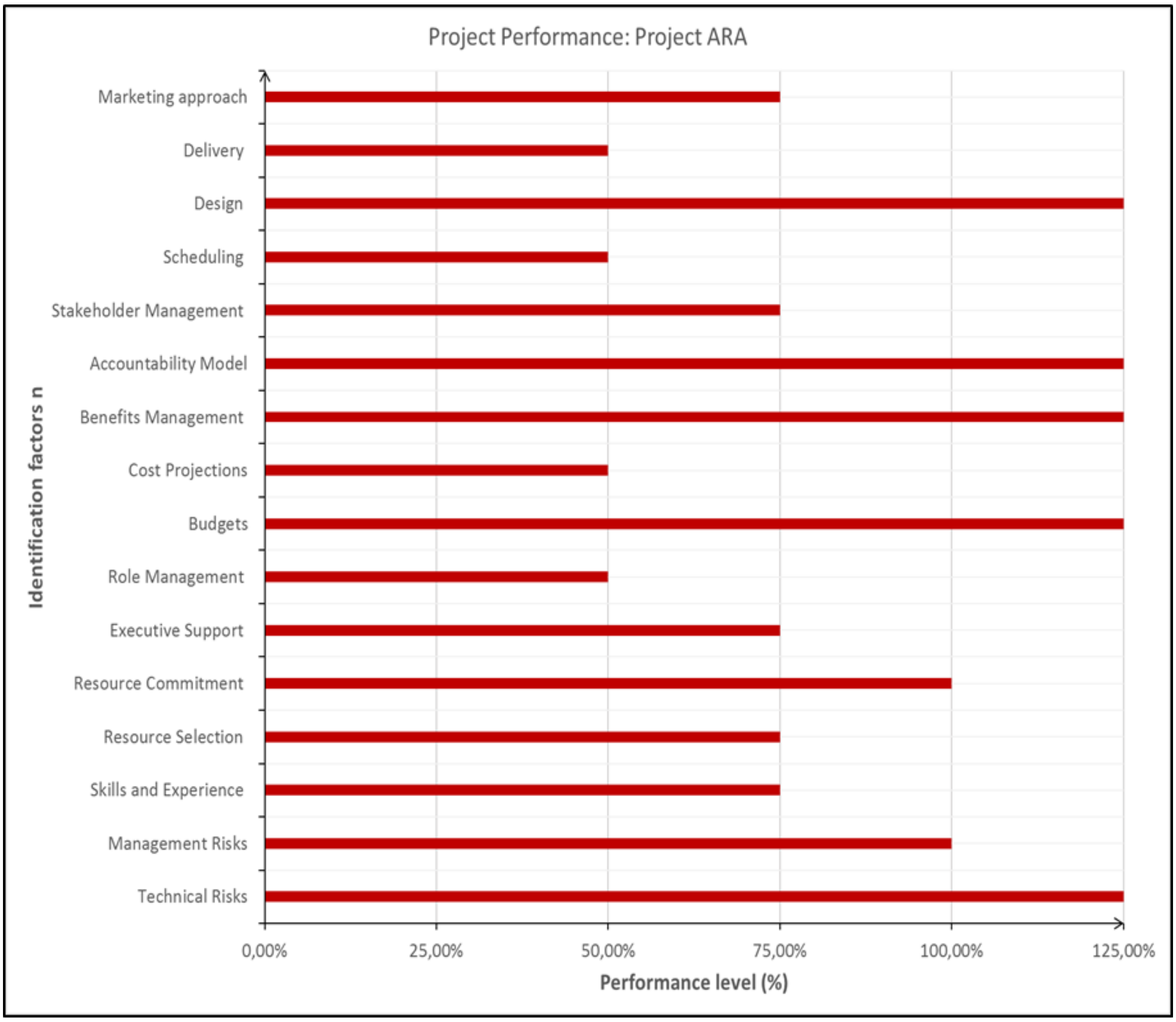
The most problematic criteria are the performance levels that have levels of about 50%. For 'Project ARA' this includes role management, cost projections, delivery and scheduling. Role management levels are so meagre, due to very non-standardized roles. The amount of managers and levels are so plentiful due to the overall large team size. Furthermore, the development process has already been more extensive, impacting the market entry date and lowering the cost projection performance. This is linked with the delivery and scheduling tasks that are also low in performance. Even though the R&D progress is in its final steps, the infrastructure is still behind scheduling.

The areas with slight underperformance are centred on the management skills, more specifically the executive support and stakeholder management. Despite some executive control being present, the problem with the work conducted during the project and the teamwork is noticeable. Stakeholder management does not reflect a high performance, since the deadline of the project and market entry keeps getting pushed, defying set goals. Linked to this is the performance of the team, in terms of skills and experience. Since the involvement of universities is rather high, the quality and time might be impacted since top-level performance cannot be reached. Despite having some highly qualified researchers, many inexperienced members ultimately lower the performance level. From this the marketing approach can be derived which takes longer the usual and is based on a lot of control work. The resource selection is impacted since most material orders are specialised and do not follow standard construction and manufacturing sources. The resource commitment has a higher performance level at 100%, with steady supply of shipped and ordered goods.

[65] (Su, March 27th 2013) (Aller, 2015/16)

The peak performances of 'Project ARA' with slight over performance are in the standardized categories: accountability, budgeting and benefits management. Since these are common tasks that follow standard procedures the performance is on point. More specifically 'Project ARA' excels in the category design, which has come a long way from the initial conceptual design idea and exceeded all expectations. The risk levels, management and technical risks are extremely high in this project. Management risks are linked to the large responsibility and complexity that comes with organizing such a large, spread out team, that partially has very little practical experience. The technical risks on the other hand are accompanied by the complexity that comes with new inventions and R&D projects.

Graph 1: Project performance 'Project ARA' (Aller, 2015/16)



These numbers were then graphed in **Graph 1**[66]. The dark line at 87,5 % indicates the average performance. Since this is a relatively high performance, the success cannot be guaranteed,

[66] (Aller, 2015/16)

but rather depends on how the lower performing factors are handled. These are mainly bringing the project to the market fast and swiftly so that the performance of scheduling and delivery is raised and cost projections can be determined more accurately. By improving the lower performance levels, the difference between success and failure can be decided.

4.4. Complexity comparison

For further insight into the managerial control needed, the complexity of a project can be a decisive factor. Table 2[67] provides an overview of the scores in complexity throughout various criteria.

Table 2: Overview level of complexity 'Project ARA' (Aller, 2015/16)

Criteria	Project ARA
Contextual	3
Social facts	4
Ambiguity	2
Project Management	2,5
Technical	4
TOTAL (of 20):	**15,5**

*Extensive version: Appendix 10: Level of complexity: 'Project ARA'

For 'Project ARA' the contextual complexity is fairly high, scoring three out of four. The power that the stakeholder has over the project, rather than the amount of stakeholders, reduces the level of independence 'Project ARA' has and drives complexity. Since the project was initiated through Google, their interest is the main concern throughout the project.

The next complexity factor is social facts, scoring a high of four out of four. This high complexity is calculated from the numerous multi-disciplinary and cross-disciplinary interactions in this project. There is a high amount of communication need between the teams worldwide, which is made difficult by the fact that the teams are very mixed in skill level, spread across locations and the general fields of expertise. This will require strong control and monitoring skills to manage.

The third factor: ambiguity lays at a mediocre two out of four points. The R&D nature of the project, as well as some level of uncertainty and assumptions when it comes to the timeframe of the project drives the complexity. Both of these aspects will need to be

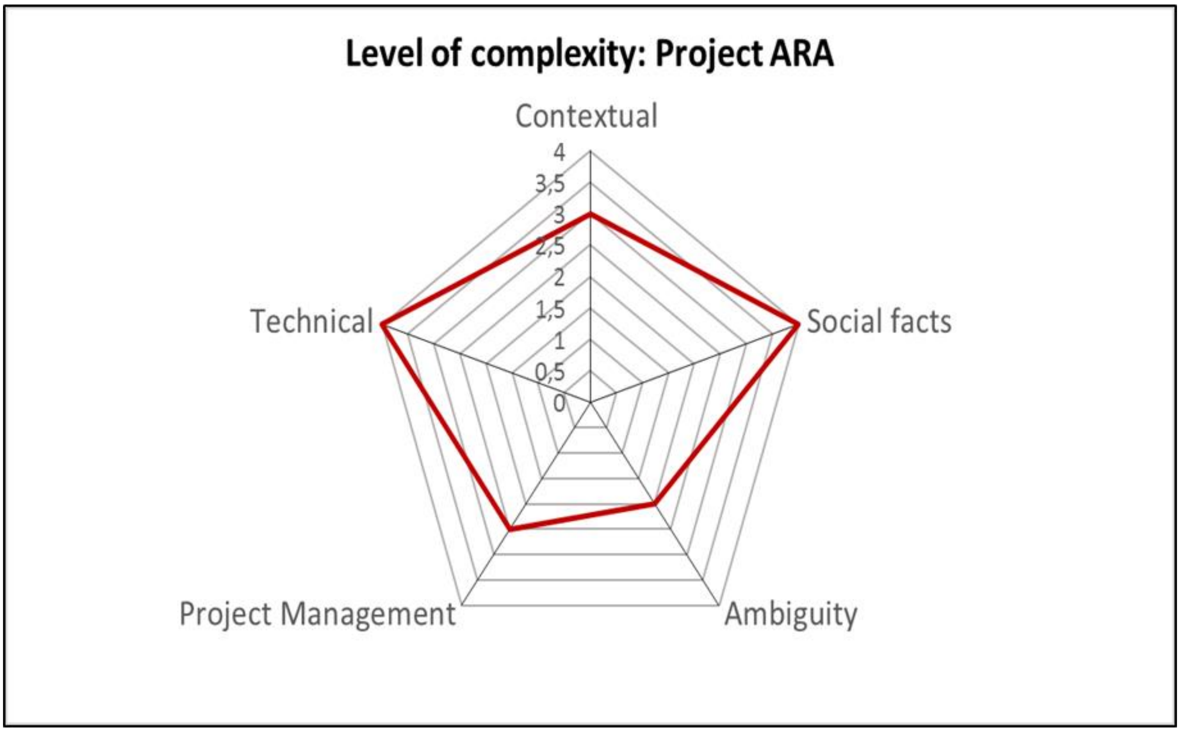
[67] (Aller, 2015/16) (Su, March 27th 2013)

considered when planning the project, keeping in mind that they could develop into potential threats.

Project management complexity is also at a mediocre level; with the root causes derived from the large team size and partially the lacking experience some of the team members have. Additional to this, there are some limitations to the flexibility of the workload, since the experts on the product cannot be replaced easily. The timeframe is also limiting and is dealt with by beneficial application of human resources.

The last and most complex criterion is the technical complexity of the project. Both the dependence on technology and its integration into the infrastructure, in form of databases and machines, is extremely high. This can turn into a high risk factor and has to be considered for the assignment of resources and when planning the schedule.

Graph 2: Level of complexity 'Project ARA' (Aller, 2015/16)



From the previous analysis **Graph 2**[68] was drawn. This spider net graph shows that the technical complexity and that arising through social factors are extremely high. For management it is vital to pay special attention to these areas when proceeding

[68] (Aller, 2015/16)

5. Case study

A project can be discussed from two angles: the objective and the subjective side.[69] Subjective measurements are always influenced by the individual's opinion and interpretation of the situation. Even if a scale is used, the exact difference in rank is decided by the judge, and can vary depending on who is in charge of judging. An objective approach on the other hand allows specific values for comparison that are without bias or prejudice.

These cases have been judged as objectively as possible, using the same scaling criteria on every factor. At the end of the line it is impossible to be completely withdrawn. This will justify he subjective disadvantage the project holds, due to a personal standpoint that cannot be negated.

For each project the above steps will be applied. Initially each project will be introduced and then classified according to the previous methodology. Here the three options are 'Type 1' to 'Type 3', ranging from successful, over challenged, to impaired. After this the performance levels and complexity levels will be scrutinized.

[69] (Ramos, 2013)

6. Electric car: Nissan Leaf, 2009

2009 Nissan signed various zero-emission contracts with countries and conducted research on possible technologies and the application of this knowledge to construct an environmental friendly vehicle.[70] In 2010 Nissan signed an agreement with Lease Plan to design the first fully electric car. This project was planned to launch in 2011 and mass-market globally from 2012 onwards. The goal was to design a zero-emission battery-powered car. Part of the distribution plan ran over Lease Plan, who provided the established customer market. Due to pre-developed technology and research the first inverter was constructed by August 2010. The first motor and complete Nissan Leaf, the first mass-produced 100% electric vehicle, rolled from the line by October 2010 and was then introduced into the U.S. and Japan by December.[71]

6.1. Classification

The Nissan Leaf project outlines a project that falls into 'Type 1', a successful project. Not only was the resulting product ready in time, or in this case ahead of time, but the quality was as promised. The goals of the initial concept have been met. According to sources the only aspect that suffered was the cost area. Originally the motor cost had been estimated at around $9000, but latest numbers indicated prices as high as $18.000.[72]

6.2. Performance

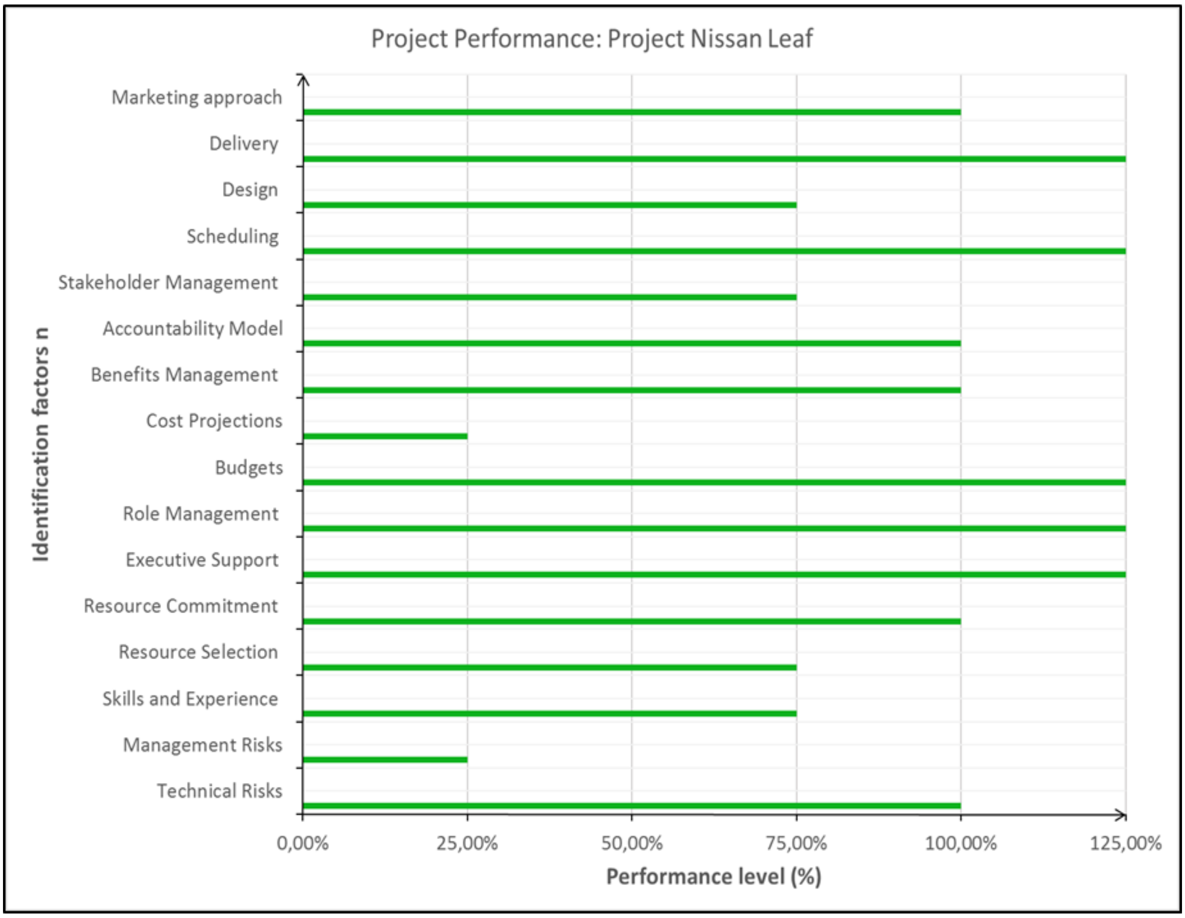
When assessing the project's success in managing various areas of concern **Appendix 1: Project performance: Project Nissan Leaf** gives an indication of the results. With this project there were many standardized tasks, since the development of a new motor is relatively normal for a car company. Resources, human and machine bases are part of an existing R&D department that is skilled in working together collaboratively. Management positions are used for handling the development of innovative products and the environment at hand. There are no real restrictions on the budget, since additional financial aid can be granted relatively easy. In this project the scheduling was impeccable, with the desired end result completed ahead of time with an intact and working design. The delivery and marketing approach are, in this case, also standardized processes.

[70] (NISSAN MOTOR CORPORATION, 2009-2013)
[71] (NISSAN, 2012)
[72] (The Wall Street Journal, 2010)

Some factors on the other hand that reflect a bad managerial control are technical risks that were initially present. The nature of the product was innovative and had never been completed before. This meant that provided research had to be efficient enough to sustain the development process and allow the eventual design of a zero-emission motor. Even though the skills and experience of R&D experts were extensive, the risk associated with this innovation still posed some potential problems. Especially for the motor material, new suppliers might have had an impact on the delivery speed and the cost. In terms of cost projections for the actual project, the estimate turned out to be very inaccurate. Not only did the motor itself end up at more than double the price, but due to profit margins the final price was increased as well.

From the above data the following Graph 3[73] was established:

Graph 3: Project performance: Project Nissan Leaf (Aller, 2015/16)



[73] (Aller, 2015/16)

Indicated by the dark line is the average performance level at 92,12%. This shows that even though the project was an overall success, the performance level especially in the areas of cost projections, management risks and the high technical risks associated with the project, were not at a high performance level. Other areas such as the delivery, scheduling, role management, budgets and resource commitment on the other hand, showed over performance and can be counted as key success factors.

6.3. Complexity

When trying to determine the outcome of a project, the level of complexity plays an enormous role. The higher the complexity of a project, the harder it is to manage and control the results. Table 3[74] shows a summary of the level of complexity.

Table 3: Overview level of complexity: Project Nissan Leaf (Aller, 2015/16)

Criteria	Nissan Leaf
Contextual	3
Social facts	1
Ambiguity	3
Project Management	2
Technical	3

*Extensive version: Appendix 2: Level of complexity: Project Nissan Leaf

The contextual complexity is placed at a three out of four. This is moderately high and can be attributed to the number of stakeholders, in this case Lease Plan. Despite having a low number of stakeholders, the actual level of control over the project this stakeholder has is extremely high. This is due to an interest in the success of the project and a stake in potential profits. An increase in communication between management and the stakeholder parties is necessary to form a feedback loop for sharing information and fulfilling the requests and concerns that might come up.

The next possible factor for adding complexity to a project is social factors. In this case the communication between disciplines and the amount of collaborative work is relatively low. Being a standardized project the work is secluded in the respective sectors. The communication is processed and controlled by the management. With a labelling of one out

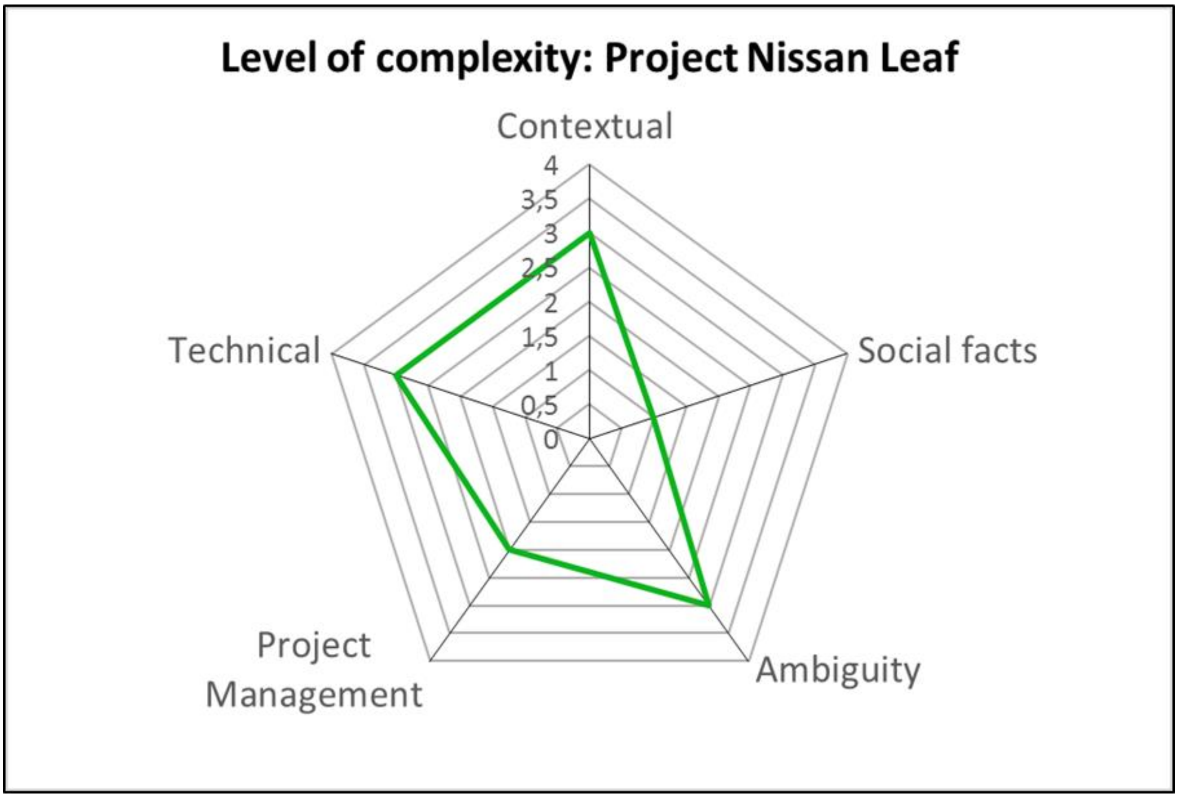
[74] (Aller, 2015/16)

of four the complexity is at a minimum and does not impact the amount of managerial control required.

The third area is ambiguity, which is determined by cost estimation, the uncertainty, assumptions and risks associated with the project. Project Nissan scored at a three out of four, which makes it another factor of complexity. Designing and developing a new type of motor comes with high risk and uncertainty. The success is never assured and drives the need for control. Another factor involved is cost estimation, a change in the budget. Since the motor costs were projected below the actual outcome, the budget had to be expanded adding to the complexity of the project.

Technical complexity[75] can be attributed to the dependence on the technology when developing a new product. The infrastructure has a relatively low dependence on technology, without any overly complex databases of programs. Most technical calculations are done with field-tested programs and calculation that the team is comfortable with using. The project's dependence on new technical developments on the other hand is higher. Without the necessary functions the product's success is not guaranteed. With a score of three out of four this is one of the main contributors to complexity.

Graph 4: Level of complexity: Project Nissan Leaf (Aller, 2015/16)



[75] (Aller, 2015/16)

Other aspects that add complexity to a project are the difficulties associated with project management. Some determinants are the general flexibility, the team size, experience, resources and the timeframe. The project team size is moderate adding a bit of complexity, but overall the team experience is high then again reducing the complexity. The large amount of resources also allows a less strict managerial control. The timeframe is very limited since a date for the market entry was set. In terms of flexibility, this case relies on a team that consists of some specialist, but with no clear dependence on an individual. With a skilled team in place, basic ideas and tasks can be traded and completed by all team members. This leads to an overall score of two out of four making it a mediocre source for complexity.

The overall conclusion in **Graph 4**[76] on the main contributors to the level of complexity is that for project Nissan Leaf, the ambiguity, the technical and the contextual factors were most influential. These were the areas that needed the most management control, so that the project can be concluded.

7. Apple iPhone, 2007

The Apple iPhone project was officially initiated in 2005, where about 200 top engineers were tasked with creating this innovative product. Speculations were that Steve Jobs was working on an entry strategy in 2004 already, approaching multiple carriers with preliminary concepts. By 2006 the prototype was still failing at the demonstration and did not work, dropping calls, failing to charge, producing corrupt and unusable data and not playing the applications. By early 2007, the Apple product was supposed to be placed as the centrepiece of the annual Macworld convention. The stakeholder AT&T had agreed to be the new iPhone carrier after 1,5 years of negotiations and agreements on 10% profit shares, and iTunes revenue. The design, manufacturing and marketing of the iPhone still rested with Apple. By Dec. 2006 the tech team had managed to put together a working prototype with brilliant screen, powerful web browser and engaging user interference. By June 29th, 2007 the iPhone went on sale and sold in huge quantities.[77]

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[76] (Aller, 2015/16)
[77] (Vogelstein, 2008)

7.1. Classification

Despite the preliminary struggles of bringing a functioning device to the public and multiple flaws in the initial prototypes, the Apple iPhone can be seen as a successful, 'Type 1' project. Even though the final product can be considered quite pricy the profit margins for Apple are very beneficiary and since the budget was not limited, the cost of the project was within bounds. With a timely market entry and the promised high quality, the final results of the project can be considered a huge success.

7.2. Performance

In order to understand the significance of all performance levels listed in **Appendix 3: Performance Overview: Project Apple iPhone**[78] it is easier group them into higher and lower percentage groups. Generally, the Apple iPhone project has very strong performance percentages; especially significant are the skills and expertise. Specifically, for this project, Apple's 200 top engineers were charged with designing this product. Also peaking in performance was the marketing approach of the product, displaying the iPhone prototype in Macworld in early 2007, providing potential customers with direct access to the product. Additional to this, role management and benefits management also express high performance levels.

Continuing with good performance areas, design can be mentioned. Despite having a faulty prototype with multiple issues, the second prototype managed to convince AT&T and the final product drew up a huge customer base. The budget for the project was unlimited and allowed the performance of tasks to succeed without restraints. Furthermore, resource selection and commitment were on high performance levels, despite innovative materials and potential new suppliers, the tested materials were ordered and delivered on time and in high quality. The executive support can also be named here, with Steve Jobs taking a personal interest in this project, controlling the speed and detail associated with the work. This was at times overbearing and hindered the engineer's progress at times.

Now one needs to take a closer look at the performance areas with low percentages. The cost projections fall into this category, since the end product was introduced into the market as one of the priciest smartphones, with Apple pulling high profits per unit sold. Another lagging performance was through the accountability model, where the engineering team

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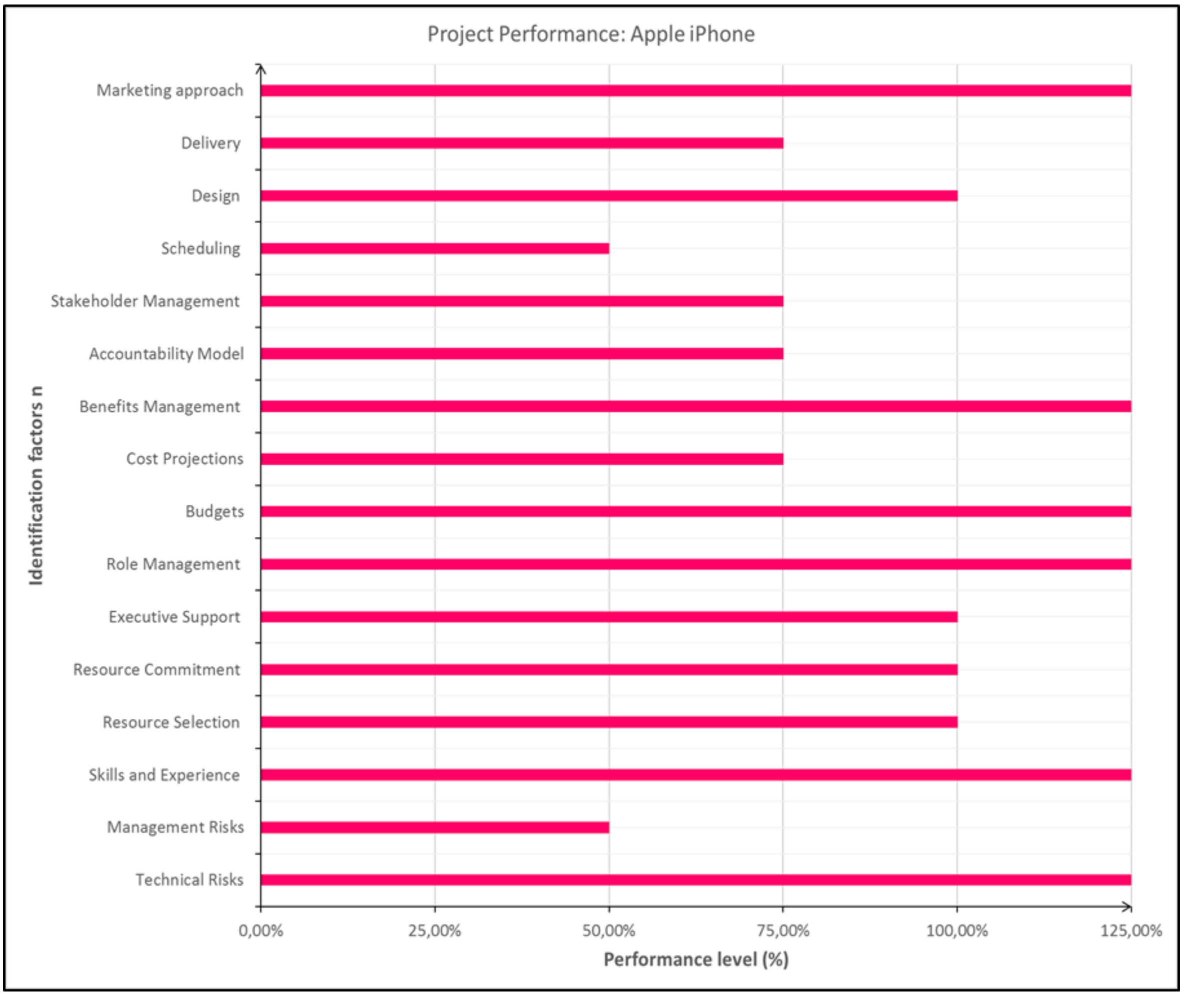
[78] (Aller, 2015/16)

was held responsible for non-controllable situations, and confronted directly. The stakeholder management was another half performance, since AT&T had such a high interest in the success of the product. The not functional prototype almost lost Apple this stakeholder, due to previously set unrealistic expectations. This links into delivery management, so even though the final product was on time, the prototypes in between did not keep up with the promises made. Job’s expectations also resulted in a stressful and unrealistic schedule for completing the project.

Graph 5: Project performance: Project Apple iPhone (Aller, 2015/16)



While the technical risks were extremely high, it being an R&D project, management risks were relatively low, since the development of a new product is a standard process. Graph 5[79]

[79] (Aller, 2015/16)

shows the data projected in a bar diagram. The average performance level lies at 96,88%, indicated by the dark line. This determines that the overall performance level was high and through the excelling nature of skills and expertise of the team and many standardized tasks, the product's success was very sure, despite high technical risks. Unrealistic scheduling, and certain mishaps in delivery, accountability, and stakeholder management and cost projections did impact the project and a more extensive analysis would have been amicable.

7.3. Complexity

When trying to identify the most vital areas of control, the overall areas of complexity have to be analysed. The scores are summarized in Table 4[80].

Table 4: Overview level of complexity: Project Apple iPhone (Aller, 2015/16)

Criteria	Apple iPhone
Contextual	3
Social facts	1
Ambiguity	3
Project Management	2
Technical	3

*Extensive version: Appendix 4: Level of complexity: Project Apple iPhone

The first criteria scored 3 out of 4 and can be considered fairly complex. While the project itself does not have that many stakeholder, AT&T does hold quite a lot of power in case of failure. The commitment and communication to the stakeholder had to be upheld, to not add to the complexity of the project unnecessarily.

Social factors in this project were very simple. Not only was there no mixing of skills, but also the only amount of cross communication was from the executive to the team of engineers, with a very straightforward line. Even though management gave the direction of the project, they left the engineers to discover the solution. Overall this category only scored a one out of four.

Ambiguity levels are fairly high again, with a three out of four. The main contributors are assumptions and uncertainty that R&D would be completed in time. The unrealistic

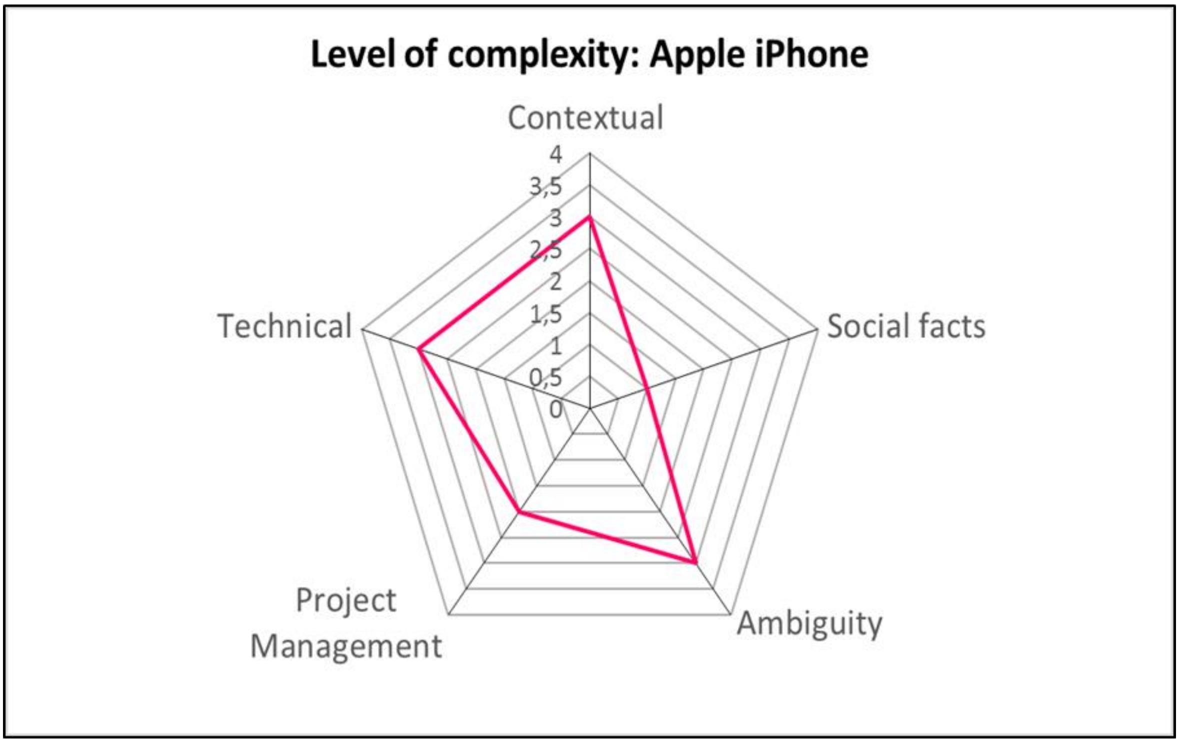
[80] (Aller, 2015/16)

timeframe of the project was eventually followed, but caused high levels of stress and it was a high risk that it would be a failure, projected through by the malfunctioning prototypes.

The complexity of project management is mediocre, despite the large team size, the task specific experience the team had helped the process run smoothly and efficiently. The only limiting factor was the set timeframe, which was possible to keep since resources and the overall flexibility of financial aid, location and expertise were supportive. Here a score of two out of four can be determined.

The final category, technical risk was again rather high, scoring a three out of four, in terms of complexity. While the projects dependence on technical infrastructure was limited to common programming databases and simple tools the R&D nature showed other results for the technical success. For the product and projects success, the technical and material knowledge had to be applied properly and in time.

Graph 6: Level of complexity: Project Apple iPhone (Aller, 2015/16)



The overall levels of complexity are summarized in Graph 6[81]. This clearly identifies the main contributors as technical, contextual and ambiguity. These had to specifically be monitored to guarantee the project's success.

[81] (Aller, 2015/16)

8. SNCF, 2014

For 2014, the French railway company SNCF had ordered about 2000 new trains. The problem with this project was that these trains were only fitted to the width of rails built in the last 30 years. This issue was not discovered until after the trains were delivered. This oversight lead to additional budget expansions for adjusting platforms at a cost of more than $68 million with more than 1000 stations still needing adjustment. The official statement is that the national rail operator RFF, a partner in this project, provided false measurements and due to insufficient communication the project can be considered a failure.[82] The problem has also been blamed on the engineers that did not double-check the theoretical data in the field.[83]

8.1. Classification

The SNCF project can be described as a 'Type 2' project, a challenged project. Even though this project will eventually be completed, the short-term quality, the overall duration and the immense increase in costs are problematic. Due to oversized trains, many stations cannot be accessed, some trains cannot pass one another and the quality of the actual product is thereby reduced. Due to the lack of communication regarding the width of rails, and the resulting changes that have to be undertaken, additional costs and a later completion date were the result.

8.2. Performance

Appendix 5: Project performance Level: Project SNCF[84] gives an overview of the overall performance in various influential areas of the project. Due to the complexity of the order many aspects were critical. One of these was design, which had to be planned according to information received from partners and passed on to the suppliers. In this case the most crucial part of communicating the right information failed completely. Not only was the final design incompatible with more than 1000 stations, but this faultiness also drove up cost projections and made the official date of completion impossible. The delivery of a functional system was also not achieved. Management risks were relatively low even though it was a large project; the assembly of the trains was external, leaving less responsibility with management. Mediocre performance was expressed in resources, the commitment and

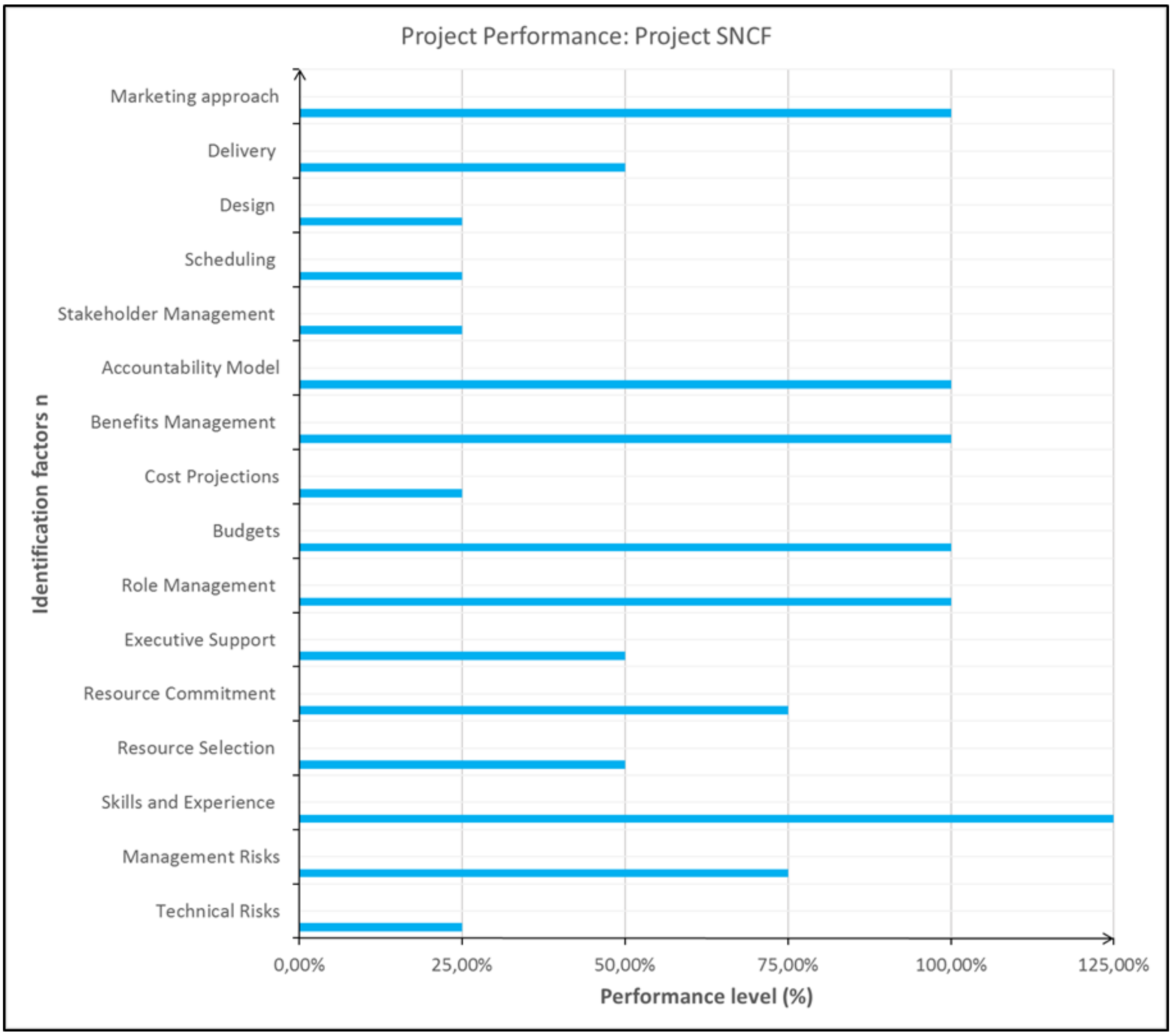
[82] (Callem Consulting LTD, 2015)
[83] (Willsher, 2014)
[84] (Aller, 2015/16)

selection as well as the executive support. Since the trains were just an update of previous models, materials and suppliers were the same, just with an improved design. The executive support depended mainly on management and experts to complete the work.

This leads to the high performance areas, which includes the standardized processes such as accountability, marketing, benefits and role management. The budget was set and even though it was eventually not followed, the extra budget had to be taken since changing the train design would have been costlier. The workers were specialists and experts that somehow forgot one of the basic tasks costing millions in Euros.

From the above table the following Graph 7[85] was created:

Graph 7: Project performance: Project SNCF (Aller, 2015/16)



[85] (Aller, 2015/16)

The darker line indicates the average performance level of the project which in this case lies at 65,63%. This is barely mediocre performance and despite the strong areas such as skills and expertise, the marketing approach and benefit management, the project cannot be named a success. Problems such as a faulty design result in problematic cost projections and scheduling issues led to the overall failure of the project.

8.3. Complexity

The next step, the analysis of the complexity of the project, is vital to determine the level of managerial control necessary. Table 5[86] summarizes this according to various criteria.

Table 5: Overview level of complexity: Project SNCF (Aller, 2015/16)

Criteria	SNCF
Contextual	3
Social facts	2
Ambiguity	1
Project Management	2,5
Technical	2

*Extensive version: Appendix 6: Level of complexity: Project SNCF

The first one is contextual measures; here a score of three out of four was reached. The high number of stakeholders determines that in this case, the SNCF, the railroad company RFF, the personnel and users of respective trains, had a direct interest in the success of the project. The actual amount of control the stakeholders have over the project is mediocre. This makes this category the most important to control.

Another category that introduces complexity is social factors. Even though there is a mediocre amount of communication between sectors, there is still need for sharing data and information on the project. The teams are generally not mixed in disciplines. The SNCF project scores a two out of four, causing little concern for management.

Ambiguity in this case plays a very small role, with a low score of one out four; management control can be kept to a minimum. The factor that drives this category is the cost estimation, which is reflected in a change of budget. The assumption and the uncertainty risk associated with this project are barely present, and not an influence factor on the overall complexity of the project.

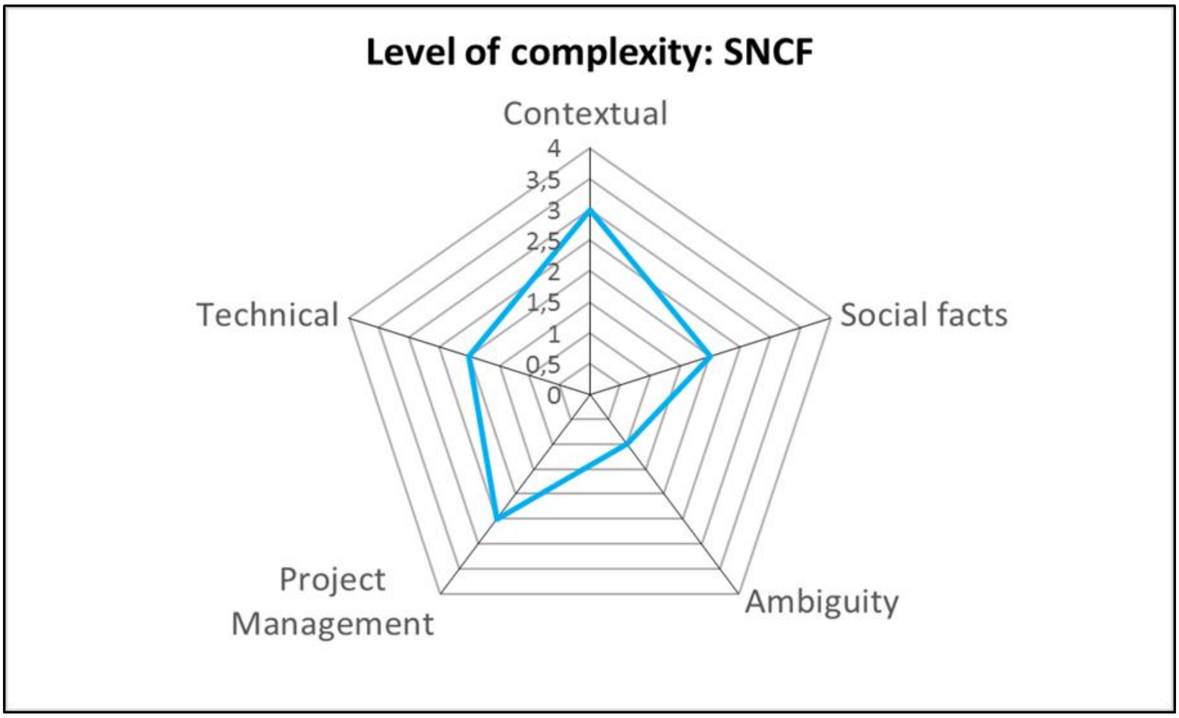
[86] (Aller, 2015/16)

The second highest factor in influencing the complexity of the project is project management. Scoring a high medium value of 2,5 out of four points, giving management some level of concern for closer monitoring and constant control. This value is contributed to a low flexibility, since the task and outcome has been fixed and the due date of the project is also pre-set. Since the resources and the timeframe are relatively strict, complexity is also added to the overall project.

The last area of potential complexity is the technical risks. Here the project lies at two out four points, again at a medium level, not giving a reason for direct concern. The general infrastructure of the project depends on technical tools, without being as vital for completing the process, since the manufacturing of the train is outsourced. The dependence on technology is kept low, minimizing the effect on the overall complexity.

From this the following graph was drawn up, which shows the data in a spider net diagram. From Graph 8[87] the main contributors to the complexity of the project can be named as contextual criteria and the project management area.

Graph 8: Level of complexity: Project SNCF (Aller, 2015/16)



[87] (Aller, 2015/16)

9. Airbus A380

This new development and design project, originally scheduled for delivery in 2006 was delayed by almost two years and cost several billion dollars over budget. The product design included one of the most complex wiring systems at that point in time, due to the extreme level of specification, a problem arose when wires turned out to be too short. Eventually the discovery was made that collaboration and communication between the 16 engineering teams, spread over four different countries, was faulty and different CAD, Computer Aided Design software, versions had been used on the designs. Overall this lead to non-compatible design versions, which included different calculation methods, configuration management failures and varying results. This lead to multiple delays, while the engineering teams tried to overcome the caused problems. The impact this relatively simple error had were grave, costing the company $6,1 billion due to the project delay.[88]

9.1. Classification

The Airbus A380 project falls into the category of a 'Type 2' projects, a challenged project. Despite being completed eventually, both time and cost suffered greatly. Due to the faulty communication between the country's engineer teams, different software was used. Not only did this cause major calculation problems, which directly affected the material ordered, but also caused multiple further delays just to sort out the problems the team faced.

9.2. Performance

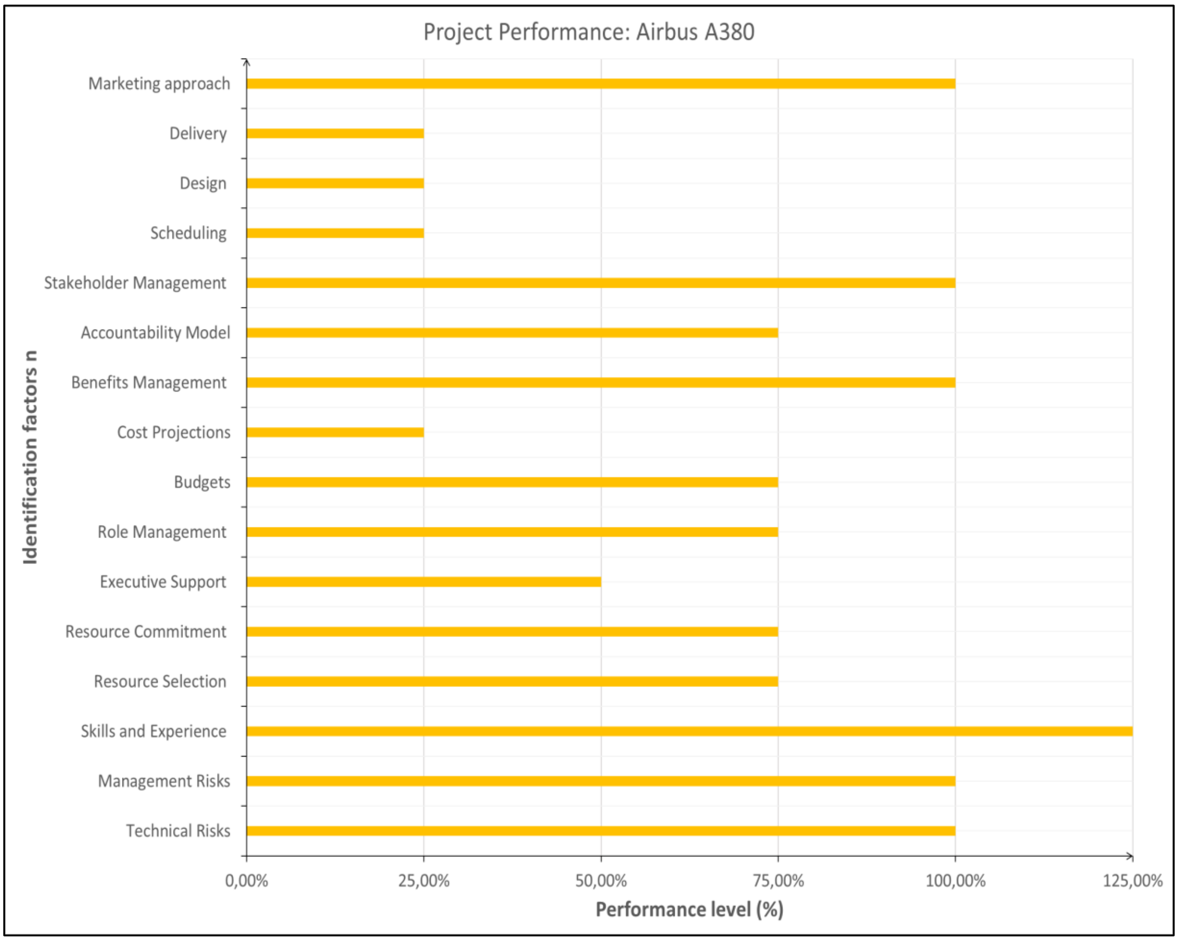
From the perceived data **Appendix 7: Performance Overview: Project Airbus A380**[89] was created. Throughout the table various performance levels indicate the areas of potential weakness that may have been responsible for causing the delay and increased cost of the project. The weakest performance areas can be identified as cost projections, scheduling, design and delivery. These are all interlinked areas and relied on the success and precision of one another. The root cause of the problem is in the design area, where miscalculations by different program versions provided false material specifications. Because of this, material had to be reordered in the correct sizes, which cost production another two years to fix this problem. It also drove up cost projections, the scheduling and the delivery of the final product. The lowest risks were in the skills the team possessed and the stakeholder

[88] (Callem Consulting LTD, 2009)
[89] (Aller, 2015/16)

management, which were clear and well developed throughout the project. Due to the size of the team, management and executive support as well as role management were challenging, with teams from multiple countries working on this project, the communication levels had to be at an ultimate high. From this the accountability levels can be determined, which are in this case spread over many levels of management, due to a relatively complex role management structure with multiple responsibility levels. High performance levels can be seen especially in the standardized tasks, such as benefit management and the marketing approach. Additionally, the general management risks, the technical risks had to be controlled immensely, since this product was the first of its kind, using highly complex wiring systems.

From the above table the following Graph 9[90] was created:

Graph 9: Project performance: Project Airbus A380 (Aller, 2015/16)



[90] (Aller, 2015/16)

The various levels of performance can be averaged on the darker line, at 71,88%. This performance level is slightly better than mediocre, but still indicating an overall underperformance of the full potential the project carries. Despite the strongest identified factors: skills and experience and stakeholder management, the weaker areas: delivery, design, scheduling and cost projections limit the success of the project.

9.3. Complexity

As another characterising method of the project, the various levels of complexity have been identified; in order to show the areas that require the most attention Table 6[91] provides an overview of the numbers.

Table 6: Level of complexity: Project Airbus A380 (Aller, 2015/16)

Criteria	Airbus A380
Contextual	2
Social facts	4
Ambiguity	4
Project Management	2,5
Technical	4

*Extensive data: Appendix 8: Level of Complexity: Project Airbus A380

The first area of complexity is contextual with a level of two out of four. The number of stakeholders is very low and is only represented as the airline that should eventually benefit from the success of the project. These results in high control measure the stakeholder has over the project. Since they are the sole investor in the project, they have complete financial and directional control of the project.

The social factor area scores at four out four. This is a result of the complex team structure, with multi-disciplinary and cross-disciplinary work, which is vital for the completion of the product. Included in this thought process is the level of communication between sectors and the dependence on management that has to relay information from top management throughout all teams in all countries. The teams have to rely on one another to complete the tasks in a high quality and perceptive manner.

Ambiguity is the third sector also ranked at four out of four. The high value is caused by problems that occurred during the project. Due to these miscalculations the cost estimations and uncertainty around the timeframe especially suffered. The general nature

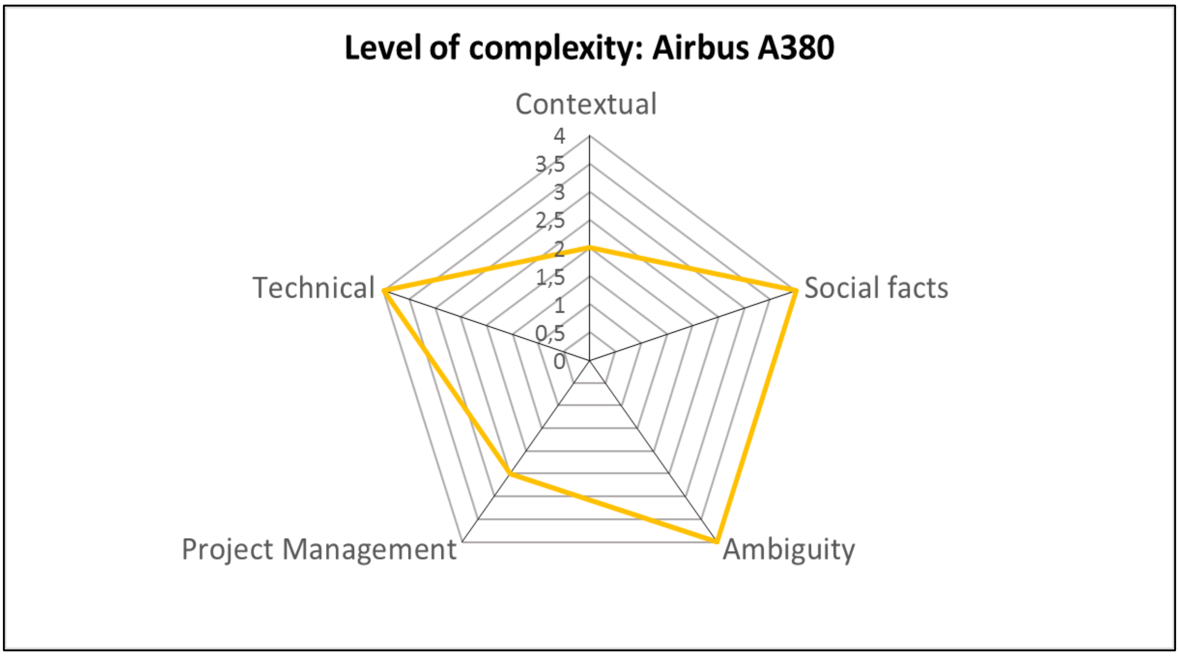
[91] (Aller, 2015/16)

of an R&D project, with technology that was never attempted before, comes with high risk and uncertainty.

Furthermore, the project management itself can be added to the complexity of a project. Here a score of 2,5 of four was reached. The main contributors are the large size of the project team, with multiple complex management structures in multiple countries. Also the resources, that were highly specialized and were ordered again due to miscalculations, made the completion of the production more complex than necessary. The timeframe could not be kept, since the tasks were not completed so that the information matched one another. Costs and time had to be increased.

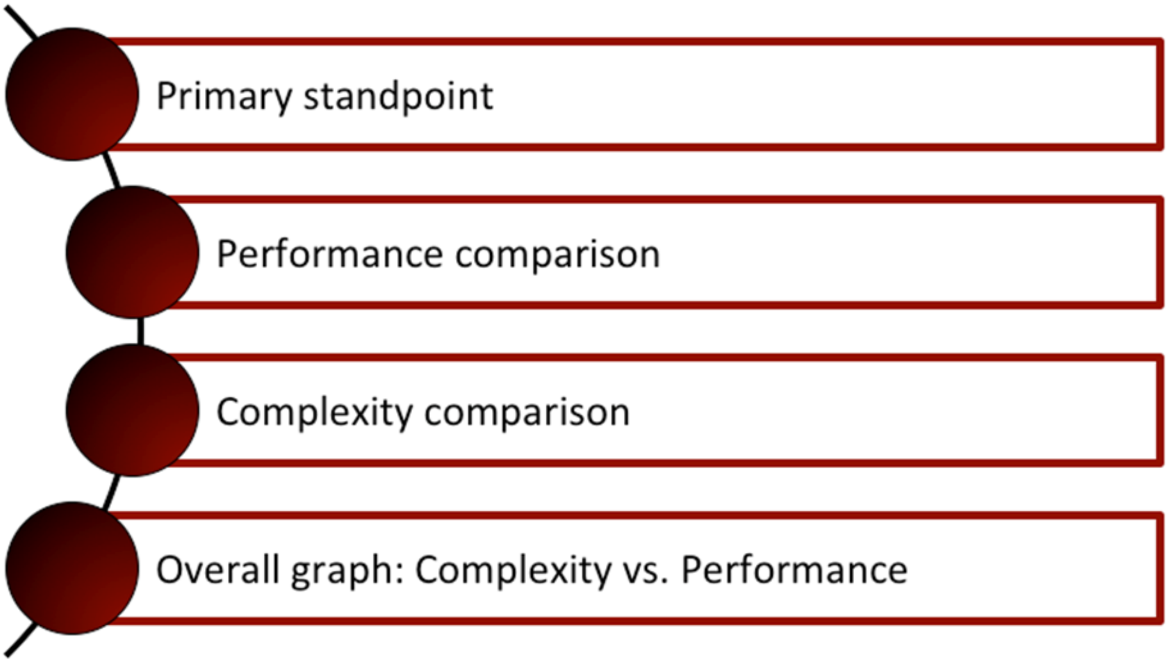
Lastly, the technical complexity of the project will be addressed. The score in this area lies at four out of four possible marks. Since the project is an R&D project, and incorporates new, complex wiring structures in the product, the project depends highly on the success of the application of the technology. Not only is the project itself technical, but also the infrastructure itself. Levels of communication and sharing of information between the teams is vital for the success of the project. The programs for designing the product are highly complex and all calculations and measurements depend on the success of applying the technology to the product.

Graph 10: Level of complexity: Project Airbus A380 (Aller, 2015/16)



From the complexity table the spider net graph was drawn. **Graph 10**[92] identifies the main contributors to complexity as: social factors, ambiguity, and technical risks. These would have required special managerial attention.

10. Compare ARA to case studies



In order to confirm the preliminary standpoint, it is vital to compare the case study data from previous cases. Even though this work only identified two successes and two failures, it will provide a general prediction of the outcome of 'Project ARA'. First the project performance will be ranked against the other projects, followed by a comparable view of the individual areas of complexity. The final step will include the graphing of the performance against the complexity. From this a trend line for the potential success can be graphed and compared to 'Project ARA'.

[92] (Aller, 2015/16)

10.1. Preliminary standpoint

From the collected data the performance of ‘Project ARA’ can be levelled at an average of 87,5 %. This measure predicts a slight underperformance, with many weak areas such as delivery, scheduling stakeholder management and executive support. With this slightly lower outcome it is crucial to be controlled by management. If not controlled further, it can impact the outcome of the project negatively. The performance percentage is high, making it possible to control the outcome by applying constant managerial control.

This in combination with the risk analysis outlines potential problematic factors. The most dominant ones include technical equipment, scheduling and skills and experience. These are internal, business and planning risks that will most likely impact the time taken for a project, and secondarily the quality and cost of the project. All three are controllable through offloading or reducing the amount of work in order to achieve the outcome and results.

The third point that flows into hypothesizing the type of project is the complexity. For ‘Project ARA’ this complexity is extremely high with a score of 15,5 out of 20. The project outlines extreme values in both technical and social factors, both scoring the highest level possible. This requires management enforce high monitoring methods, in order to deal with these potential risk factors that can cause a project to fail.

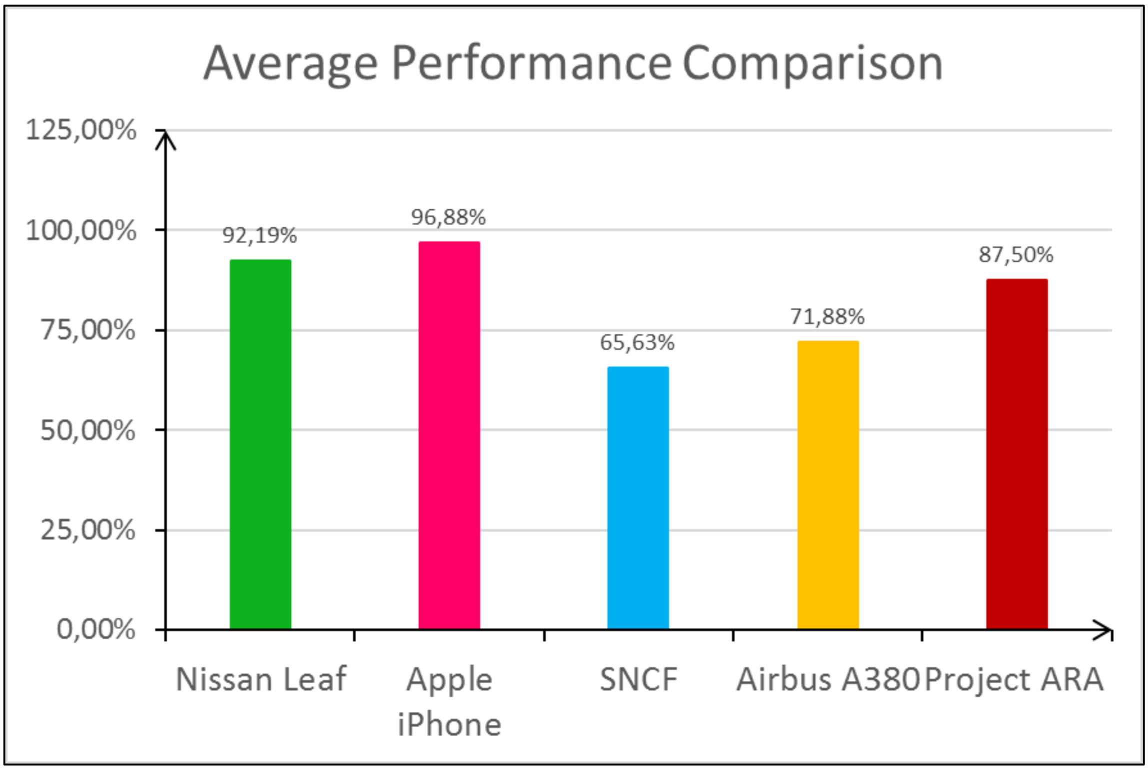
Overall this leaves one to conclude that ‘Project ARA’ lies between becoming a ‘Type 1’ and ‘Type 2’, either predicting a successful or challenged outcome. If managerial control is high enough and complexity levels are reduced, the risk factors are taken into consideration and the performance levels are raised, then the project has the potential to be successful. If these suggestions are not applied, the project will most probably become a 'type 2' project.

10.2. Performance monitoring

Graph 11[93] compares average performance levels of the analysed case studies and 'Project ARA'. The successful projects: Nissan Leaf and Apple iPhone have high values between 90 to 100%, while the failures range between 65 and 75%. As the graph indicates 'Project ARA' lies in between the two levels. Since the amount of data we have limits the accuracy of the results, general assumptions have to be made. In this case it can be said that 'Project ARA' is in a grey zone, with its average performance level of 87%, it is closer to the average performance levels of successful projects with only 3% off.

The conclusive information from the performance data solely, would rank 'Project ARA' as a 'Type 1' project, a success, even if this is not as certain as for the previously studied cases. This result can only occur if the performance levels are increased from what they currently are and the performance of all tasks are monitored and a constant feedback loop is upheld.

Graph 11: Average Performance Comparison (Aller, 2015/16)



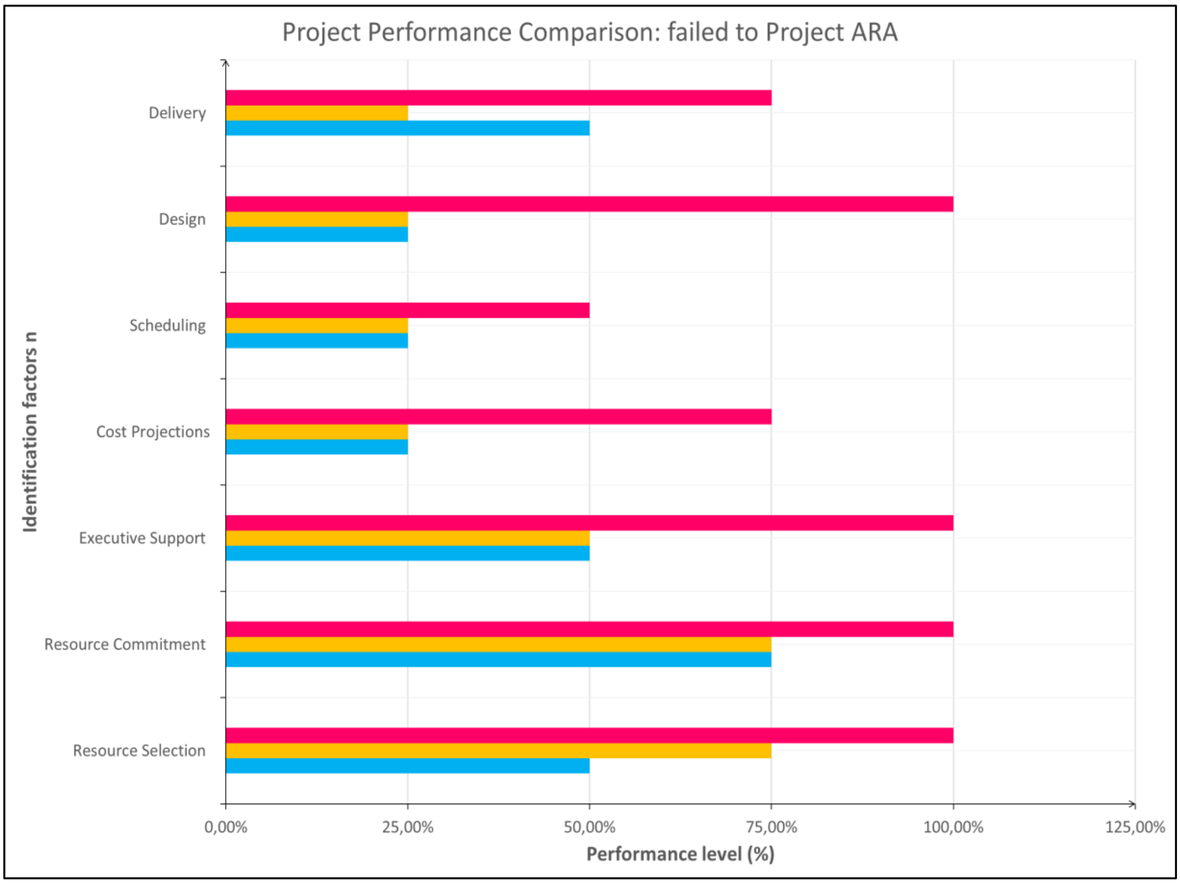
Since the average performance has so many criteria, it is important to identify the specific contribution factors and identify any overlap. 'Project ARA' is graphed against the two successful and then the two failed case studies. From there the key drivers for failure and

[93] (Aller, 2015/16)

for success will be identified. Depending on how dominant the overlap is, the more precise the determination of governance factors will be.

Graph 12[94] provides an overview of the weakest performance categories and might give indications of the factors that caused the overall failure of the projects.

Graph 12: Project Performance comparison: failed project to 'Project ARA' (Aller, 2015/16)



*more detailed information **Appendix 11: Performance Projections: failed projects**

Low performance factors, both case studies share are: design, scheduling and cost projections, not exceeding a 25% mark. Since ARA does not match any of those criteria and lays at least one bar above those criteria, in some cases such as with design even recognizably higher, these can be flagged as criteria that need to be monitored.

In addition, criteria that are equally high are executive support at 50% and resource commitment at 75%. Again ARA exceeds these low performances by at least 25% and comes into full performance levels. Despite a lower performance in executive support, the amount of managerial control regular check-ins will be sufficient for managing these areas.

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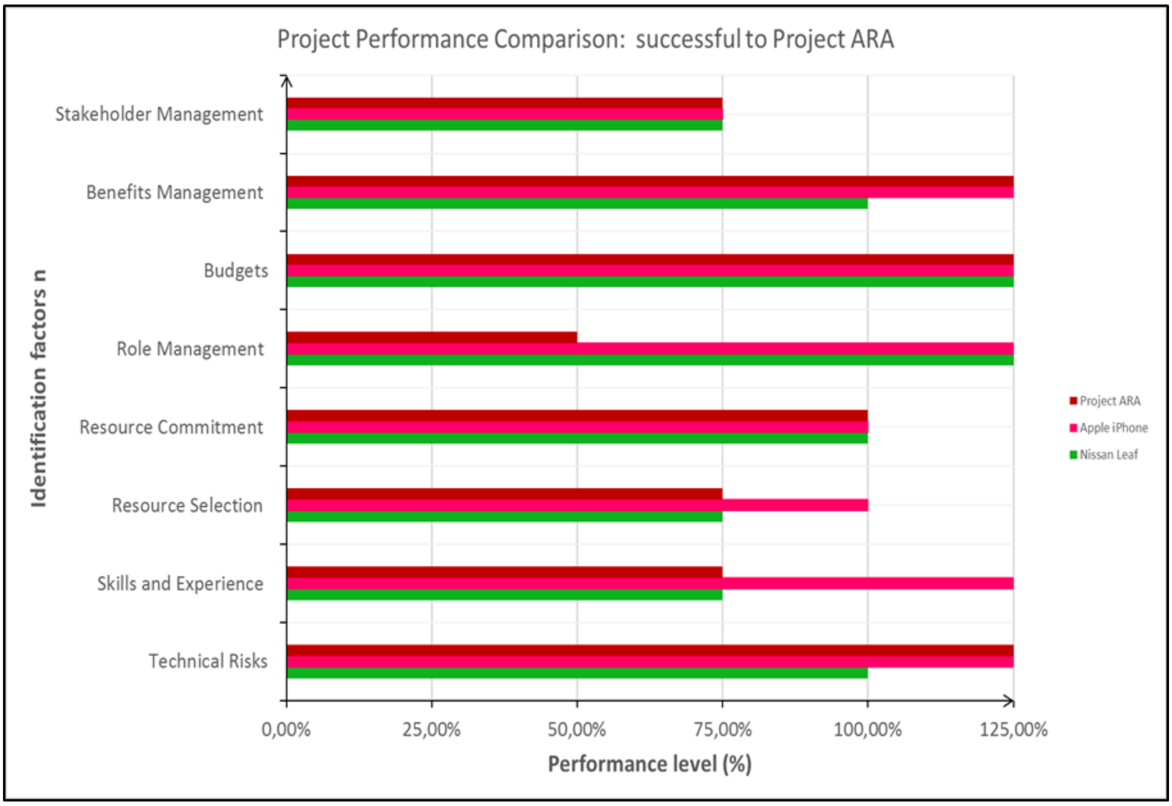
[94] (Aller, 2015/16)

Criteria where 'Project ARA' levels with one of the failed projects are delivery, with 50% performance levelled with SNCF and resource selection at 75% with airbus A380. Both criteria are probably the most important in this analysis, since they indicate that this performance levels in that these specific criteria were partially cause for the project failure. These are areas that need close monitoring so that they do not impact 'ARA' negatively.

When ranking the successful projects against each other, many similarities can be identified in Graph 13[95], which could be indicators for key success drivers. The performance levels that both case studies rank the same, are stakeholder management, budgeting, resource commitment and role management. When regarding 'Project ARA' in comparison, a level of 75% performance can be seen for stakeholder management, matching the performance of the successful projects. Additionally, the resource commitment ranks at 100%, between the three projects, as well as budgeting at 125%. Since these are at the same level the required managerial control will be very low.

Graph 13: Project Performance Comparison: successful to 'Project ARA' (Aller, 2015/16)



*more detailed information: Appendix 12: Performance projections successful projects

The criteria in which 'Project ARA' ranks considerably lower than the two successes are role management, which is due to the team size of 'Project ARA'. The percentages of the

[95] (Aller, 2015/16)

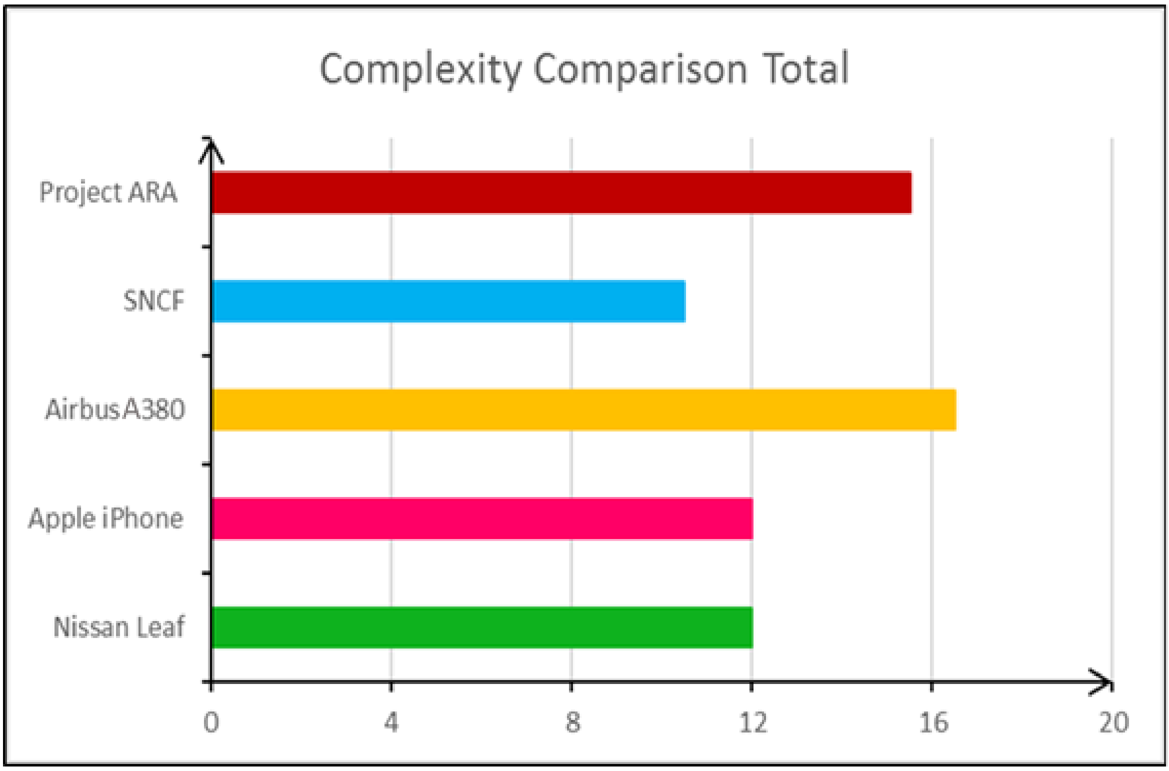
successful projects lie at 125% with standardized processes, against a meagre 50% ARA promises. This leads to a conclusive behaviour of extremely high attention from management, to implement a precise reporting structure, so that no information shortages occur.

The third group is indicated through areas in which ARA scores the same as one of the projects. This is true for the criteria: benefits management, skills and expertise, resource selection and technical risks. The matching levels of performance indicate that these levels of performance have been high enough to guarantee a successful project. Therefore, managerial control can be periodically.

10.3. Complexity comparison

The complexity comparison provides further insight into the nature of the projects, and state, which require specific managerial control. The higher the complexity, the harder it is for management to control the outcome of the project. From this it can be concluded that the higher the complexity the less likely the success of the project.

Graph 14: Complexity level comparison – total score (Aller, 2015/16)



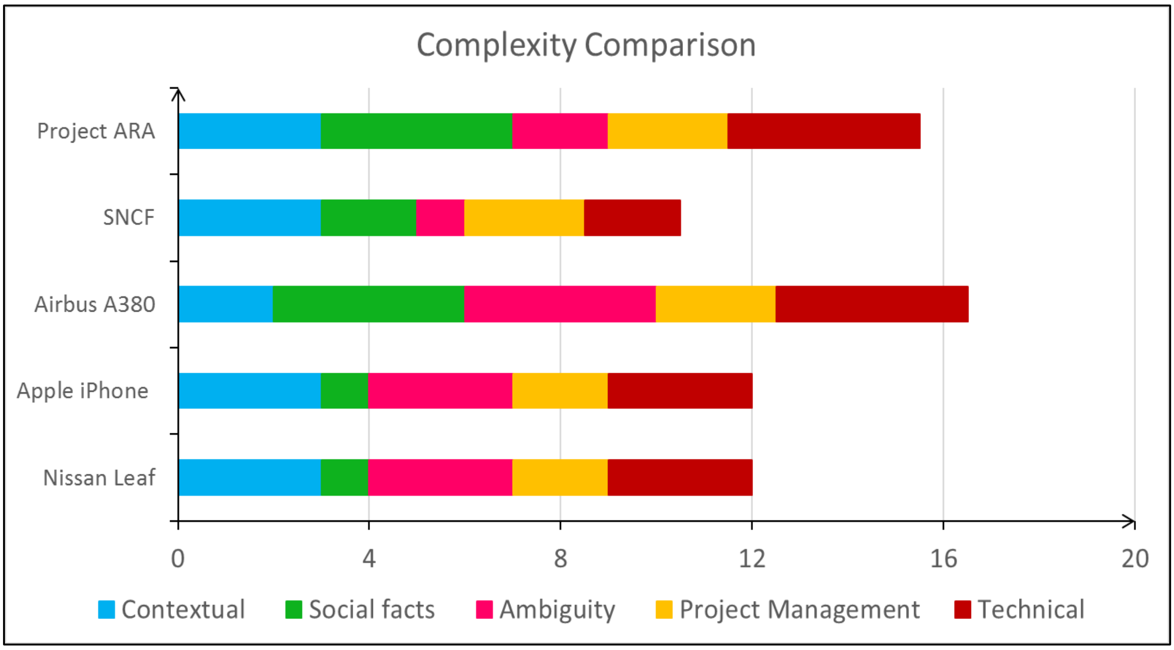
Graph 14[96] shows the complexity per project and ranks them against each other. Both success stories have a mediocre level of complexity ranking at 12 out of 20 potential points. The non-successful projects show either an extremely high level of complexity such as Airbus A380 with a level of 16,5 out of 20 points, or a low complexity in the SNCF project with only 10,5. The high level of complexity in the airbus A380 project can be cause for its failure. SNCF despite having a very low level complexity still turned out to be a failure. From this a general statement can be given that the level of complexity to some extent does not guarantee the success or failure of a project, but rather how management handles the performance levels and risks.

When comparing the values from 'Project ARA' to this, its complexity is at 15,5 points out of 20. This is a high level of complexity and lies closest to the failed project Airbus A380. On the other hand, the other failed project has a much lower complexity level. For the purpose of determining the potential success or failure of 'ARA', the general concept is that high complexity will most likely result in the failure of the project. This would then mean that, considering the data, 'Project ARA' has such a high complexity, that the likelihood of it being a failure is very high. This would predict 'ARA' as a 'Type 2' project. Overall it would fall into the category of a challenged project, where the negative impact is reflected in the time, quality or cost of the project.

[96] (Aller, 2015/16)

Going into further detail, **Graph 15**[97] provides an overview of the various projects divided into the five complexity categories: contextual, social factors, ambiguity, project management and technical complexity.

Graph 15: Complexity level comparison (Aller, 2015/16)



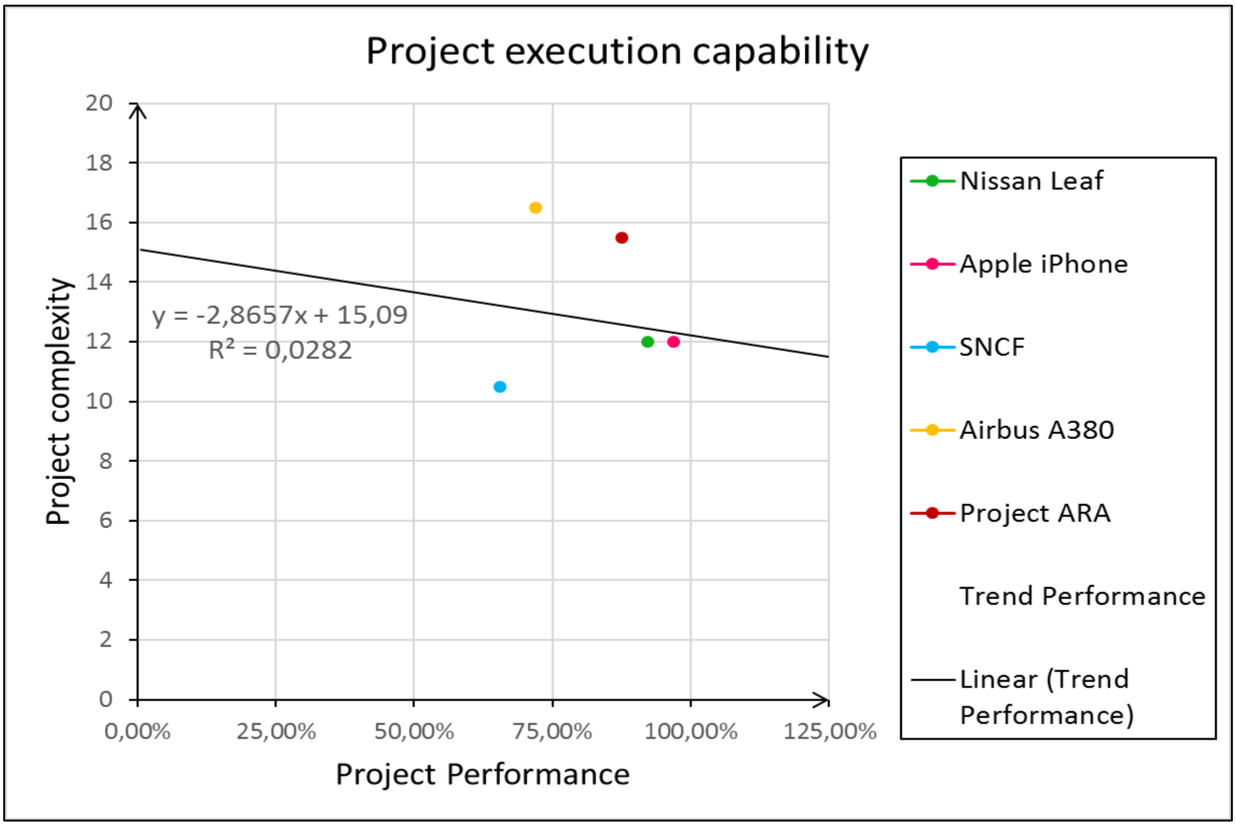
When evaluating 'Project ARA' against the given factors from successful and failed projects, the main concern will be to find the overlap to the successes stories and the failed projects. This will be done by category. In terms of contextual complexity, 'Project ARA' matches with both successful projects and with the failed project SNCF at a complexity of three. This is the only category where the complexity matches. ARA is decisively more complex than the successful projects in three categories: social factors, project management and technical complexity, where it rather matches the failed projects. The fifth criteria, ambiguity is actually much lower than that of the successful projects, again reducing the overall failure of the project. Overall this indicates that only two out of the five complexity characteristics predict a successful project.

[97] (Aller, 2015/16)

10.4. Graphical comparison

When graphing the collected values, **Graph 16**[98] shows the results.

Graph 16: Project execution capability comparison (Aller, 2015/16)



When paying attention to the successful projects, the coordinates lie closely together, and nearly match the trend line. They have almost 100% in performance levels and a mediocre complexity score. When assessing the failed projects one notices that their performance levels are much lower falling below 75%. Their complexities differ widely and cannot be compared. While Airbus A380 lies far above the trend line, SNCF lies far below it. This general trend indicates that the lower the project performance, the less likely the project is to succeed. In terms of complexity, a lower complexity is generally better, but mixed with low performance levels, even the lowest complexity level can cause a project to fail.

[98] (Aller, 2015/16)

From this the three statements can be produced:

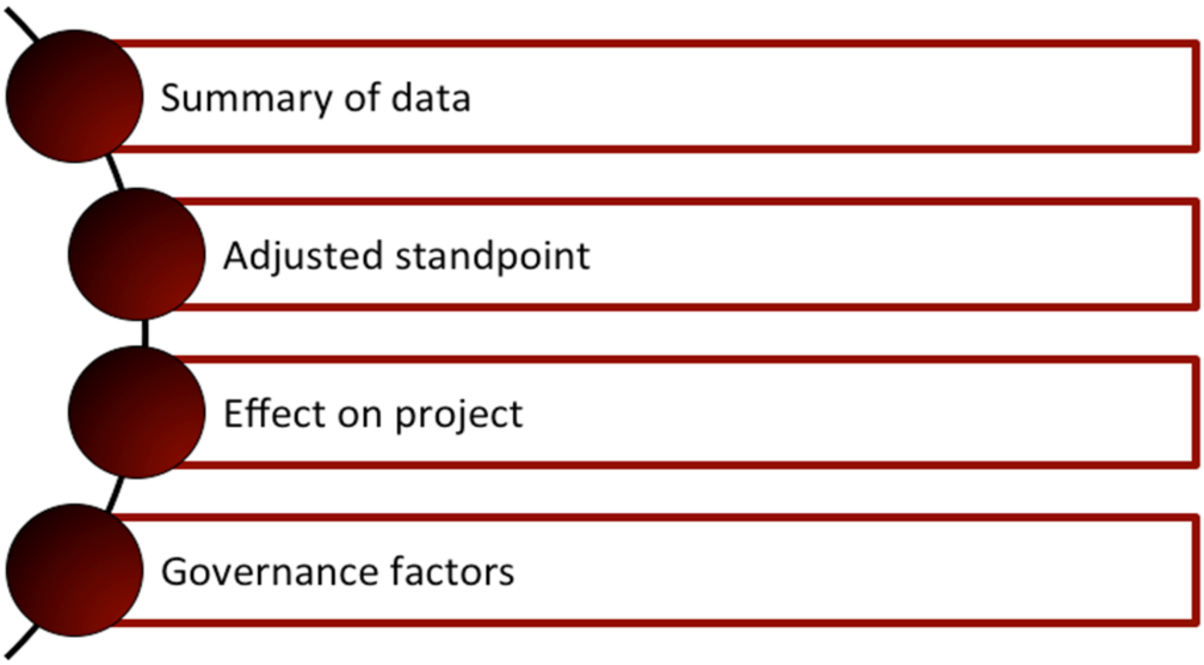
- High performance level (75% +) is most probable to lead to success
- Low complexity (12 and lower) generally indicates success
- If performance levels are below 75%, even low complexity levels will cause the project to fail.

Additionally, the calculated trend line will give an indication of the complexity level by performance level, which will allow a success in the project.

$$y = -2{,}8657x + 15{,}09$$

The accuracy of this trend line is very low with an r^2 =0,0282. This value normally ranges between 0 and 1, whereas any value above 0,85 indicates that the linear equation represents the data in a statically significant and correct way. This inaccuracy is partially due to the lack of overall data and that there are only four sets of data. With more readings the line and r^2 would become more precise and outliers in the typical data could be recognized.

11. Conclusion



In conclusion the previously collected data be summarizes to provide a complete overview of the results. According to these results the preliminary standpoint will be adjusted. Furthermore, the effects of the result on the project overall will be listed and potential governance factors will be suggested.

11.1. Summary of data

When assessing 'Project ARA' through **Graph 16** and the previous analysis the following can be collected:

1. In terms of performance levels, 'Project ARA' is very likely to succeed (Type 1)
2. In terms of complexity levels, 'Project ARA' is likely to fail (Type 2)

Just assessing the performance levels, 'Project ARA' with its 87% average performance, resembles the successful projects. Specific traits that are shared as key success drivers are benefits management, skills and expertise, resource selection and technical risks. Factors that speak against the success of the 'ARA' are delivery and resource selection.

Continuing on to the complexity levels, 'Project ARA' scores 15,5 points out of 20. This high level of complexity lays closest to a failed project. When assessing the individual complexity criteria, 'ARA' is decisively more complex than the successful projects. This is especially true for the three categories: social factors, project management and technical complexity, where it rather matches the failed projects. Speaking against its failure, in terms of complexity is only the criteria ambiguity, where its complexity is much lower than any other project.

Now in order to assess this through the graphed values it become clear that 'Project ARA' does not follow the trend line. But from the previously set rules, it can be predicted that 'Project ARA' will indeed become a 'Type 2' project. Despite the fact that performance levels are slightly higher than those of the failed projects, this performance level will most likely not be enough to cope with the high complexity of the project.

11.2. Revised standpoint

When comparing this with the initial stand point, where one would suggest project's out-come to lie between 'Type 1' and 'Type 2', but with a higher tendency of becoming a 'Type 2' project, the results from a comparison to the case studies shows similar results. The results however provide a confirmation that 'Project ARA' will indeed become a 'Type 2' project. This statement is founded in the level of complexity, despite the tendency to succeed when only viewing the performance levels.

11.3. Effect on project

The overall effect on the project will be a reduction in final product quality, an extended timeframe or a raise in the projected costs. Since the project has not been concluded yet the potential governance factors can tip the scale towards a success or challenging project.

11.4. Identification of governance factors

After the results have been collected, it was identified that 'Project ARA' is most likely to become a 'Type 2' project. Since this falls into the category of challenged projects, either the quality, cost or time will be impacted. In order to minimize the negative impact and maybe even improve the project from a 'Type 2' to a 'Type 1', governance factors have to be applied to the areas that are the most problematic.

Taking Figure 14 on page 30 into consideration, the first governing group is the internal audit, which focuses on the key risks. As identified these include the planning risk of task scheduling and the Internal risks effective scheduling and technical equipment, as well as the business risks with the skill level of the workers. Similar to the approach when previously assessing the risk, the internal audit will have to come up with solutions to reduce, offload or accept the consequences of these risks. The financial risks controlled through the external audit lie in the space availability and the potential extra fees or taxes linked in a more dominant support of local businesses. Both committees will have to present their findings to the audit committee. A clear picture has to be created, so that management can apply governance factors and controlling methods.

Senior management, that are responsible for the daily supervision, planning and administrative process to reach company goals, will have to especially focus on the high social factors and the high technical complexity. Both factors are potential problematic areas that could contribute to the failure of 'Project ARA'. This is reflected in the performance monitoring through factors such as role management, which has a weak performance. Furthermore, performance levels have to be improved for the delivery, the scheduling and the cost projections. If these regions are improved, the project will have a good chance of not failing and slipping to 'Type 1' identification.

The board of directors that receives the feedback from the senior management will then have to take all of the provided data into account and manage its goals accordingly. This will then have to be reported to the stakeholders of the project that in this case have a slightly underperforming standpoint and could be included more in the project.

Since the project is also controlled through government laws and taxes, as well as the program governance itself, it is vital that communication levels are kept high and data on the newest successes or even failures is shared. If these suggestions are taken into consideration the negative impact on quality, time and cost can be minimized.

12. Summary

12.1. Process to develop method

The thought process that went into developing a method to determine the success or failure of project is based on simple project management processes. The inclusion of classification, risk analysis, performance and complexity levels and the final comparison to previous case studies was an essential part of this process. Through the application of this model, and a slight revision of the methods presented through Deloitte, into an own interpretation of the data, allowed the creation of a model. While keeping the constraint triangle in mind, time, quality and cost, the data was analysed, only to conclude in a prediction with the addition of potential governing factors.

12.2. Limitations and weaknesses

The adaptation of Deloitte's method, with addition of extra steps in the model for determining the success of a project can be counted as a success. Not only did it aid in prediction a logical outcome for 'Project ARA', but it also allowed insights into key driving factors for the success or failure of projects.

Potential weaknesses of this method were, that the final graphical comparison between the projects only used four case studies as comparative data, limiting the value of a trend line. Furthermore, in this project only 'Type 1' and 'Type 2' projects were analysed, which was mainly due to the fact that 'Type 3' projects are buried by the company and data is inaccessible. If this method were to be applied within a company, the model would benefit from the inclusion of more sets of data.

13. Sources

Aller, C. (2015/16).

Ara Endo (Medium Variant). (n.d.). Retrieved 10 19, 2015, from https://tctechcrunch2011.files.wordpress.com/2014/04/screen-shot-2014-04-10-at-11-08-15-am.png?w=738

Attarzadeh, I., & Ow, S. (2008). Project Management Practices: The Criteria for Success or Failure. In U. o. Department of Software Endineering, *Communications of the IBIMA.* Kuala Lumpur: University of Malaysia. Retrieved 11 15, 2015, from http://www.ibimapublishing.com/journals/CIBIMA/volume1/v1n28.pdf

Business Dictionary. (n.d.). Definition Innovation. Retrieved 11 02, 2015, from http://www.businessdictionary.com/definition/innovation.html

Business Dictionary. (n.d.). *Risk management.* Retrieved 02 27, 2016, from Business Dictionary.com: http://www.businessdictionary.com/definition/risk-management.html

Business Dictionary. (n.d.). *Senior management.* Retrieved 02 27, 2016, from BusinessDictionary.com: http://www.businessdictionary.com/definition/senior-management.html

Callem Consulting LTD. (2009, 04 11). *Airbus - A380.* Retrieved 02 27, 2016, from International Project Leadership: http://calleam.com/WTPF/?p=4700

Callem Consulting LTD. (2015, 08 21). *International Project Leadership Academy.* Retrieved 02 10, 2016, from SNCF: http://calleam.com/WTPF/?p=6708

Cambridge Business English Dictionary. (n.d.). *Government Regulation.* Retrieved 02 27, 2016, from Cambridge Dictionaries: http://dictionary.cambridge.org/dictionary/english/government-regulation

Desi Tribe. (2015, 01 15). Project Ara Phone is Finally Released, Spiral 2 Prototype. Retrieved 10 19, 2015, from https://www.youtube.com/watch?v=ZlsawrmaEgU

Eremenko, P. (2015, 06 27). Google's Project Ara Prototype Demo. Retrieved 10 19, 2015, from https://www.youtube.com/watch?v=0He3Jr-fZh0

Eremenko, P. (2015, 02 03). Project ARA DevCon2 Highlights. Retrieved 10 19, 2015, from https://www.youtube.com/watch?v=8KYohXfYkRc

Financial Times. (n.d.). *Definition of audit committee.* Retrieved 02 27, 2016, from Financial Times ft.com/lexicon: http://lexicon.ft.com/Term?term=audit-committee

Fishman, D. (2015, 02 03). Project Ara Spiral 2 Demo. Retrieved 10 19, 2015, from https://www.youtube.com/watch?v=TUefug-8aaI

Hakkens, C. (Director). (12th Sept 2013). *Phonebloks - The ultimate phone concept* [Motion Picture]. YouTube. Retrieved 10 19, 2015, from https://www.youtube.com/watch?v=CfK-7lp-DhU

Hakkens, C. (2013, 11). *Phonebloks*. Retrieved 09 12, 2015, from Phonebloks-The ultimate phone: http://phoneblocks.com/in-the-press/ abgerufen

Hanford, M. (2005, 04 15). *Program governance and structure.* Retrieved 02 27, 2016, from IBM developerWorks: http://www.ibm.com/developerworks/rational/library/apr05/hanford/

Investopedia. (n.d.). *Board of Directors - B of D.* Retrieved 02 27, 2016, from Investopedia: http://www.investopedia.com/terms/b/boardofdirectors.asp

NISSAN. (2012). *Nissan's Electric Vehicle History.* Retrieved 02 08, 2016, from http://www.nissan-global.com/EN/DOCUMENT/PDF/AR/2012/AR2012_E_p13_EV_History.pdf

NISSAN MOTOR CORPORATION. (2009-2013). *News Releases*. Retrieved 02 08, 2016, from http://www.nissan-global.com/EN/NEWS/2009/10_12.html

Project ARA. (n.d.). *Project ARA.* Retrieved 10 12, 2015, from http://www.projectara.com/

Project Management Institute Inc. (2010). *Project Management Institute.* Retrieved 11 16, 2015, from What is Porject Management: http://www.pmi.org/About-Us/About-Us-What-is-Project-Management.aspx

Projektmanagement Manufaktur. (n.d.). *Projektmanagement Manufaktur.* Retrieved 10 26, 2015, from Risikoanalyse im Proejtkmanagement (mit Beispiel und Vorlage: http://www.projektmanagement-manufaktur.de/risikoanalyse-projektmanagement

QTC Control Services. (n.d.). *Project Management Triangle.* Retrieved 02 15, 2016, from QTC Control Services: http://www.qualitytimecost.com/clients/test-page-two

Ramos, J. A. (2013, 12 05). *Objective and subjective performance measures.* Retrieved 01 30, 2016, from LinkedIn SlideShare: http://de.slideshare.net/jhunarar/objective-and-subjective-performance-measures

Su, J. (March 27th 2013). *Enabling risk anayltics for project success.* Retrieved 11 15, 2015, from https://chapters.theiia.org/calgary/ChapterDocuments/IIA%20Luncheon%20-%20March%202013%20-%20PPA%20Final.pdf

TenStep. (2014). Six reasons companies struggle implementing project management. Retrieved 02 15, 2016, from http://tenstep.pt/six-reasons-companies-struggle-implementing-project-management/

The Verge. (2014, 04 15). Google's Project Ara: Reinventing the smartphone with building blocks. Retrieved 10 19, 2015, from https://www.youtube.com/watch?v=PQqudiUdGuo

The Wall Street Journal. (2010, 05 15). WSJ: Nissan Leaf profitable by year three; battery cost closer to $18,000. *Autoblog*. Retrieved 02 08, 2016, from http://www.autoblog.com/2010/05/15/nissan-leaf-profitable-by-year-three-battery-cost-closer-to-18/

Toader, C.-S., Brad, I., Adamov, T., Marin, D., & Moisa, S. (2010). The Main Causes which Lead to Success or Failure of a Project. In T. C. al., *Scientific papers: Animal Science and Biotechnologies* (2nd ed.). Romania. Retrieved 11 15, 2015, from http://www.usab-tm.ro/fileadmin/fzb/Simp%202010/VOL%202/MANAGEMENT/Toader%201.pdf

Turnkey Consulting. (n.d.). *What is the difference between internal and external audit?* Retrieved 02 27, 2016, from Turnkey Consulting: http://www.turnkeyconsulting.com/faq/what-is-the-difference-between-internal-audit-and-external-audit/

Vogelstein, F. (2008, 09 01). *WIRED*. Retrieved 03 07, 2016, from http://archive.wired.com/gadgets/wireless/magazine/16-02/ff_iphone?currentPage=all

Willsher, K. (2014, 05 21). *the guardian.* Retrieved 02 10, 2016, from French railway operator SNCF orders hundreds of new trains that are too big: http://www.theguardian.com/world/2014/may/21/french-railway-operator-sncf-orders-trains-too-big

Wohlin, C., & Andrews, A. (2005). *Evaluation of Three Methods to Predict Project Success: A Case Study.* Oulu, FI: Springer Verlag. Retrieved 12 15, 2015, from http://www.wohlin.eu/profes05-1.pdf

Determining the success of innovative projects using performance and complexity indicators

Case: ‘Project ARA’

Appendix

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Bachelor Thesis for Bachelor of Arts & Business Administration (Hon.) - Double Degree

Double Degree Programme in International Business

Turku, April 2016

Index of figures

Appendix 1: Project performance: Project Nissan Leaf (Aller, 2015/16)

n	Nissan Leaf	Comments
Technical Risks	100,00%	When attempting to design new inventions, a high technical risk is assosciated
Management Risks	25,00%	The project is a standard task, where the same management process is applied
Skills and Experience	75,00%	Highly skilled professional were wokring to complete the porject, but since the area of expertise was unknown complication probability was high
Resource Selection	75,00%	Resources are ordered at standard delivery, but the material is highly specialised.
Resource Commitment	100,00%	High commitment level from standard suppliers, potential problems with new suppliers
Executive Support	125,00%	The task was provided and all support required will be given
Role Management	125,00%	The roles are standardized
Budgets	125,00%	The budget is very flexible, as with most R& D projects, they are primarily an investment
Cost Projections	25,00%	The cost for the product were gravely underestimated
Benefits Management	100,00%	Beneftis on outstanding performance are standardized as general bonus
Accountability Model	100,00%	The most accountability lies with higher managerial positions
Stakeholder Management	75,00%	Clear tasks, close collaboration with Lease Plan and contractors
Scheduling	125,00%	The product and market entry was ahead of schedule
Design	75,00%	The previous designs of the exterior and interior were used, but the motor was designed from scratch
Delivery	125,00%	The delivery was ahead of time, due to less lenghtly production times and well developed manufacturing plants.
Marketing approach	100,00%	The marketing approach was through the usual channels by the marketing team

Appendix 2: Level of complexity: Project Nissan Leaf (Aller, 2015/16)

Criteria	Criteria defined	highest possible score	Nissan Leaf
Contextual		**4**	3
# of stakeholders	high number - high complexity	2,00	2
Power of stakeholders	independence from stakeholder (opinion, financial, control)	2,00	1
Social facts		**4**	**1**
Multi-disciplinary	amount of communication between sectors, how dependant on mgmt	2,00	1
Cross disciplinary	mixed skilled teams, sector work	2,00	0
Ambiguity		**4**	3
Cost Estimation	change in budget	1,00	1
Assumptions & Uncertainty	change in timeframe, quality, unrealistic	2,00	1
Risk	especially R&D projects, higher likelihood to flop	1,00	1
Technical		**4**	3
Integration complexity	level of dependence (project itself)	2,00	2
Impact on infrastructure	tools (database, entirely technical)	2,00	1
Project Management		**4**	2
Flexibility	dependence on location, individual's expertise, financial, if high, then complexity is high	1,00	0
Project Team size	the larger the more complex	1,00	1
Project Team experience	high qualifications = low complexity	0,50	0
Resources	unlimited = low complexity	0,50	0
Timeframe	not bound = low complexity	1,00	1

Appendix 3: Performance Overview: Project Apple iPhone (Aller, 2015/16)

n	Apple iPhone	Comments
Technical Risks	125,00%	The development of the iPhone, included completely new concepts that had never been applied to a funtional product before
Management Risks	50,00%	The task at hand was the standard development of new product, with high R&D characteristics
Skills and Experience	125,00%	The team consisted of the 200 top engineer's Apple had, with high qualifications and experience in the field
Resource Selection	100,00%	The resources were ssued by standard suppliers, and new material for the innovative conepts was tested and applied accordingly
Resource Commitment	100,00%	The resources were ordered and delivered in a timely manner, according to the demand.
Executive Support	100,00%	With personal interst Steve Jobs controlled the speed and accuracy of the design, every step of the way
Role Management	125,00%	The process was divided by tasks and collaborative communication within the team, with normal management positions
Budgets	125,00%	The budget was not limiting in any way
Cost Projections	75,00%	The iPhone turned out to be one of the priciest smartphones, with Apple pulling in huge profits per sold unit
Benefits Management	125,00%	The benefits are standardized and depend on performance
Accountability Model	75,00%	The accountability was with the team of engineers, that were confronted directly in case of problems.
Stakeholder Management	75,00%	AT&T as stakeholder held a high interest in the success of the product, but could be confirmed after many failed trails, by the working prototype
Scheduling	50,00%	The scheduling did work out in the end, but the three months before the iPhone was due to exhibit included a too high task load in too short time
Design	100,00%	The design on the prototypes was initially flawed, but ended up to be one of the most brilliant in modern smart phone industries
Delivery	75,00%	While the first prototype had a faulty delivery, the second one convinced stakeholders, and the final product convinced the market
Marketing approach	125,00%	The marketing approach was very glamorous, with the iPhone being a centerpiece at the Macworld exhibiton

Appendix 4: Level of complexity: Project Apple iPhone (Aller, 2015/16)

Criteria	Criteria defined	highest possible score	Apple iPhone
Contextual		**4**	3
# of stakeholders	high number - high complexity	2,00	1
Power of stakeholders	independence from stakeholder (opinion, financial, control)	2,00	2
Social facts		**4**	1
Multi-disciplinary	amount of communication between sectors, how dependant on mgmt	2,00	1
Cross disciplinary	mixed skilled teams, sector work	2,00	0
Ambiguity		**4**	3
Cost Estimation	change in budget	1,00	0
Assumptions & Uncertainty	change in timeframe, quality, unrealistic	2,00	2
Risk	especially R&D projects, higher likelihood to flop	1,00	1
Technical		**4**	3
Integration complexity	level of dependence (project itself)	2,00	2
Impact on infrastructure	tools (database, entirely technical)	2,00	1
Project Management		**4**	2
Flexibility	dependence on location, individual's expertise, financial, if high, then complexity is high	1,00	0
Project Team size	the larger the more complex	1,00	1
Project Team experience	high qualifications = low complexity	0,50	0
Resources	unlimited = low complexity	0,50	0
Timeframe	not bound = low complexity	1,00	1

Appendix 5: Project performance Level: Project SNCF (Aller, 2015/16)

n	SNCF	Comments
Technical Risks	25,00%	The project was a mere updated version of older existing technology, with newer parts but no extreme change
Management Risks	75,00%	The team was extremely large, with information recieved from various sources, which then had to be combined into one product. The risk was relatively high.
Skills and Experience	125,00%	The team consisted of experts on the topic, that had done work and projects like this beforehand with experience of the topic
Resource Selection	50,00%	Due to the large amount of material that was ordered resource selection was dependant on fast efficient delivery of the specialized order. Despite having many standardized parts
Resource Commitment	75,00%	The same suppliers as ususal were used, but due the size of the order the supplier had to be prepared, and with such huge amounts complications arise.
Executive Support	50,00%	The support was mediocre at most, since it was a standard project, management didn't monitor the team as closely
Role Management	100,00%	The roles in management were standardized
Budgets	100,00%	The budget was set as a target to aim for, but could be increased if neccessary
Cost Projections	25,00%	The project overshot the budget by great lengths due to extra work on the rails, which were the result of miscommunication
Benefits Management	100,00%	The benefits are standardized and given as boni.
Accountability Model	100,00%	The accountability is held be the company, rather than a single employee since management failed to communicate.
Stakeholder Management	25,00%	The communication of concepts and information to and between stakholder groups failed completely.
Scheduling	25,00%	Due to the faulty prouct design the scheduling of completing the project was postponed and took immense work to complete even then.
Design	25,00%	The desing was faulty, since the trains were overall too large which led to multiple problems, the lack of communication of information is to blame.
Delivery	50,00%	The product itself was delivered in time, but the faulty design prevented th usage of the product
Marketing approach	100,00%	The marketing of the product was not that necessary, since it is a public service, but the process was thrugh standard approaches.

Appendix 6: Level of complexity: Project SNCF (Aller, 2015/16)

Criteria	Criteria defined	highest possible score	SNCF
Contextual		**4**	3
# of stakeholders	high number - high complexity	2,00	2
Power of stakeholders	independence from stakeholder (opinion, financial, control)	2,00	1
Social facts		**4**	2
Multi-disciplinary	amount of communication between sectors, how dependant on mgmt	2,00	1
Cross disciplinary	mixed skilled teams, sector work	2,00	1
Ambiguity		**4**	1
Cost Estimation	change in budget	1,00	1
Assumptions & Uncertainty	change in timeframe, quality, unrealistic	2,00	0
Risk	especially R&D projects, higher likelihood to flop	1,00	0
Technical		**4**	2
Integration complexity	level of dependence (project itself)	2,00	1
Impact on infrastructure	tools (database, entirely technical)	2,00	1
Project Management		**4**	2,5
Flexibility	dependence on location, individual's expertise, financial, if high, then complexity is high	1,00	1
Project Team size	the larger the more complex	1,00	0
Project Team experience	high qualifications = low complexity	0,50	0
Resources	unlimited = low complexity	0,50	0,5
Timeframe	not bound = low complexity	1,00	1

Appendix 7: Performance Overview: Project Airbus A380 (Aller, 2015/16)

n	Airbus A380	Comments
Technical Risks	100,00%	The technical risk is extremely high, since this product will be first to apply complex wiring of ist kind. The likelihood that something will go wrong is very large.
Management Risks	100,00%	Management had to be point to control the high risk that comes with such a large team spread over multiple countries all designing this comple product.
Skills and Experience	125,00%	All team members are highly skilled and experts in their field, with a lot of experience on similar topics.
Resource Selection	75,00%	Since the resources are all specialized, the selection is very dependant on calculations of the design, which were in this case flawed.
Resource Commitment	75,00%	Since material had to be ordered twice, due to miscalcuations the resources for production were delayed.
Executive Support	50,00%	The executive support was limited by the fact that a lot of information got lost through the management levels, and communication was only to the next superior.
Role Management	75,00%	The reporting hierarchy was specialized, it was overly complex since the time size and responsibility was spread over multiple countries.
Budgets	75,00%	The budget for the airplane was set, but could be enlarge if necessary.
Cost Projections	25,00%	The project overshot the budget, since the miscalculations led to repeated material orders, with a delay in production
Benefits Management	100,00%	The benefits are standardized, and dependant on the individual engagement issued in the form of boni.
Accountability Model	75,00%	The accountability is attributed over a larger target group, due to the large team size.
Stakeholder Management	100,00%	The decriptors of the end product was clear and the communication to stakeholders was on point, the problems were caused through internal communication.
Scheduling	25,00%	Due to miscalculations and the adjustment of material and production, the schedule was not on point, and compeltiong two years too late.
Design	25,00%	The design calculations were faulty, due to non compatible programs that applied different formulas.
Delivery	25,00%	The delivery of the product was delayed due to the faulty desing.
Marketing approach	100,00%	The marketing approach followed standard procedure.

Appendix 8: Level of Complexity: Project Airbus A380 (Aller, 2015/16)

Criteria	Criteria defined	highest possible score	Airbus A380
Contextual		**4**	2
# of stakeholders	high number - high complexity	2,00	0
Power of stakeholders	independence from stakeholder (opinion, financial, control)	2,00	2
Social facts		**4**	4
Multi-disciplinary	amount of communication between sectors, how dependant on mgmt	2,00	2
Cross disciplinary	mixed skilled teams, sector work	2,00	2
Ambiguity		**4**	4
Cost Estimation	change in budget	1,00	1
Assumptions & Uncertainty	change in timeframe, quality, unrealistic	2,00	2
Risk	especially R&D projects, higher likelihood to flop	1,00	1
Technical		**4**	4
ntegration complexity	level of dependence (project itself)	2,00	2
mpact on infrastructure	tools (database, entirely technical)	2,00	2
Project Management		**4**	2,5
Flexibility	dependence on location, individual's expertise, financial, if high, then complexity is high	1,00	0
Project Team size	the larger the more complex	1,00	1
Project Team experience	high qualifications = low complexity	0,50	0
Resources	unlimited = low complexity	0,50	0,5
Timeframe	not bound = low complexity	1,00	1

Appendix 9: Project performance level: 'Project ARA' (Aller, 2015/16)

n	Project ARA	Comments
Technical Risks	125,00%	High technical risk, completely new R&D project, with new invention that has never been produced before
Management Risks	100,00%	High management responisbility for a large, spread out team, where some have very little practical experience
Skills and Experience	75,00%	Some very highly qualified researches, but due to the inclusing of university, many inexperienced
Resource Selection	75,00%	Specialised orders, mainly material orders, that are not standardized
Resource Commitment	100,00%	Order placement and shippment follow each other without delay
Executive Support	75,00%	Focus lies on work within a team, rather than high managerial or executive control
Role Management	50,00%	High management aspects, since there are many non-standard roles, due to the team size
Budgets	125,00%	Standardized R&D budget, the target is the development of the project, not necessarily the budget
Cost Projections	50,00%	Longer development phase than planned, lets suspect that cost is also increased
Benefits Management	125,00%	Standardized process, issued as boni at the end of year or contract
Accountability Model	125,00%	Accountability lies with management
Stakeholder Management	75,00%	On track, since prototypes reflect the work progress, despite being slightly slower than expected with the market entry
Scheduling	50,00%	Product market entry has been pushed back multiple time, R&D itself is ready, but infrastructure etc. is missing
Design	125,00%	Design follows and exceeds the initial conceptual idea
Delivery	50,00%	Delivery to the market of end product is behind schedule
Marketing approach	75,00%	Based on detailed market research, very detailed but rather slow

Appendix 10: Level of complexity: 'Project ARA' (Aller, 2015/16)

Criteria	Criteria defined	highest possible score	Project ARA
Contextual		**4**	**3**
# of stakeholders	high number - high complexity	2,00	1
Power of stakeholders	independence from stakeholder (opinion, financial, control)	2,00	2
Social facts		**4**	**4**
Multi-disciplinary	amount of communication between sectors, how dependant on mgmt	2,00	2
Cross disciplinary	mixed skilled teams, sector work	2,00	2
Ambiguity		**4**	**2**
Cost Estimation	change in budget	1,00	0
Assumptions & Uncertainty	change in timeframe, quality, unrealistic	2,00	1
Risk	especially R&D projects, higher likelihood to flop	1,00	1
Technical		**4**	**4**
Integration complexity	level of dependence (project itself)	2,00	2
Impact on infrastructure	tools (database, entirely technical)	2,00	2
Project Management		**4**	**2,5**
Flexibility	dependence on location, individual's expertise, financial, if high, then complexity is high	1,00	0,5
Project Team size	the larger the more complex	1,00	1
Project Team experience	high qualifications = low complexity	0,50	0,5
Resources	unlimited = low complexity	0,50	0
Timeframe	not bound = low complexity	1,00	0,5

Appendix 11: Performance Projections: failed projects (Aller, 2015/16)

Projections	SNCF	AirbusA380	Project ARA
Resource Selection	50,00%	75,00%	75,00%
Resource Commitment	75,00%	75,00%	100,00%
Executive Support	50,00%	50,00%	75,00%
Cost Projections	25,00%	25,00%	50,00%
Scheduling	25,00%	25,00%	50,00%
Design	25,00%	25,00%	125,00%
Delivery	50,00%	25,00%	50,00%

Appendix 12: Performance projections successful projects (Aller, 2015/16)

Projections	Nissan Leaf	Apple iPhone	Project ARA
Technical Risks	100,00%	125,00%	125,00%
Skills and Experience	75,00%	125,00%	75,00%
Resource Selection	75,00%	100,00%	75,00%
Resource Commitment	100,00%	100,00%	100,00%
Role Management	125,00%	125,00%	50,00%
Budgets	125,00%	125,00%	125,00%
Benefits Management	100,00%	125,00%	125,00%
Stakeholder Management	75,00%	75,00%	75,00%