

“We don’t want to miss the boat”

A research on factors of good collaboration in an innovative context.
A case-study on the RAMLAB network, based in the Port of Rotterdam.



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385489 – MAY 2020
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CHAPTER 1: INTRODUCTION OF RESEARCH

In this chapter the subject of this research will be introduced: innovative collaboration in the RAMLAB network. The problem statement is presented, followed by the research questions. Then the objectives of this research are explained and this chapter concludes with the societal and scientific relevance.

1.1. Problem Statement

While reaching the end of the second decennium of the 21st century it becomes clear that everyday life shows some serious differences from previous periods. In a short period rapid successive developments with regard to information technology, use of data, globalisation and the internet have succeeded each other. Analogue technology has been replaced by digital technology; digital processes and linked chain processes have gained ground. Knowledge economy, complex processes and high-pitched technology are increasingly dominant in today's society (Timmerman, 2019). Improvement is booked and progress is made, likewise in the maritime sector.

WAAMPeller, the first certified 3D printed ship propeller

22-10-2019, M2i

At the end of November 2017 the world's first Class approved 3D printed ship's propeller, the WAAMPeller, was revealed at Damen Shipyard Group's headquarters in the Netherlands. This ground-breaking success is the result of a close collaboration between RAMLAB, Promarin, Autodesk, Bureau Veritas and Damen. Two M2i Postdoc researchers worked on the successful WAAMPeller.

The five-company partnership started pooling their collective resources and knowledge to develop the world's first 3D printed ship's propeller in the first half on 2017. Promarin provided the design of the triple-blade propeller. The Port of Rotterdam's RAMLAB (Rotterdam Additive Manufacturing LAB) carried out fabrication using Wire Arc Additive Manufacturing (WAAM) techniques, supported by Autodesk's expertise in software, robotics and additive manufacturing. Damen provided Research and Development resources in addition to one of its Stan Tug 1606 vessels for operational testing purposes. Bureau Veritas' role was to verify the entire development, production and testing process.



Article 1. News update M2i, 2019.

First 3D-printed ship's propeller in Guinness Book of Records

11-04-2019, TU Delft

The first 3D-printed ship's propeller, the WAAMPeller, which was co-produced by a researcher of the Department of Materials Science and Engineering, has been given a place in the 2019 Guinness Book of Records.

The researcher is an expert in the area of large-scale 3D printing of steel, and for his research he is working at the Rotterdam Additive Manufacturing LAB (RAMLAB). In collaboration with RAMLAB, Promarin, Autodesk, Bureau Veritas and Damen, he participated in the project of producing a ship's propeller with Wire Arc Additive Manufacturing (WAAM) technology, a 3D printing process with welding wire. The prototype of the propeller has a diameter of 1,350 mm and weighs around 400 kilograms.

A major challenge in the project was to prove that the material properties WAAMPeller are comparable to casting. The ship's propeller is made from Nickel Aluminium Bronze alloy (NAB). Because the WAAMPeller is constructed layer by layer and not in one step, the microstructure becomes finer and the mechanical properties become superior in comparison to casting. The second prototype was produced and certified by Bureau Veritas, installed on a tug boat and passed all the stringent tests. Research is being done in incorporating multiple metals in a single propeller. This will bring the technology a step further, as the performance of propeller can increase with the use of stronger metals in combination with more corrosion resistant metals.

Article 2. News update TU Delft, 2019.

The articles mention a ground-breaking success that has been booked in the maritime sector: the first certified 3D-printed ship propeller. It is something that has never been accomplished before, something new and innovative. They emphasize that this has been achieved through collaboration, rather a close collaboration between several relevant actors. The articles mention the pooling of resources and knowledge, expertise, involvement of research and development departments and Postdoc researchers, all characteristics of networks specialised in innovation. In addition, it is mentioned that the project was

a major challenge, with strict tests before getting it certified. And with significant results: “*bringing technology a step further*” (TU Delft, 2019, p. 1). This is an example of the emergence of cooperation based on a need for each other’s specialism and resources, in this case new technology. One company provides expertise in data, one in R&D resources, another the design and so on. There is a diverse group of actors involved: a software company, a shipyard, a university, a certifying company, a knowledge institution; all working together for one purpose: the development of WAAM (3D-printing).

This specific development is being executed at RAMLAB, one of the actors mentioned in the article and the research subject of this thesis. RAMLAB is an innovative company located in the port of Rotterdam. Their mission is to live in a world where the WAAM process is the dominant process for manufacturing metal parts on demand. To achieve their mission, they focus on developing cutting edge technology, with related hardware and software technologies. They want to bridge the gap between the academic and industrial sector, by making technologies applicable for the maritime sector (RAMLAB, 2019). RAMLAB acknowledges the power and necessity of having a diverse, complimenting network they work with and work for. They combine and exchange resources to achieve their ambitions, a path they have to walk together with their innovative network members. The RAMLAB network consists of 26 members, which have the joint-goal of further developing WAAM technology and making it applicable for the maritime sector. This specific network is the subject of this thesis.

However, this is not the only example of heterogeneous actors teaming up. Collaboration initiating from interdependencies is a trend that is seen more and more often. It is a trend that arises from growing complexity, the growth of profound knowledge and demand for institutional capacity. One organisation alone does not have the necessary knowledge and resources to move forward, but needs others to do this. As a result, the demand for collaboration occurs (Ansell & Gash, 2007). And with this rising demand also the demand for networks increases.

Necessary research has been carried out on network collaboration, but there is room and need for more (Bekkers & Tummers, 2018). Questions as: ‘What makes network collaborations successful? What contributes to that? And, what not? Why do actors join? What factors are most important for successful collaboration? What scares actors away? What specific way of collaboration is most preferred by actors? And how can you sustain this?’ rise. This research focusses on these questions and applies them on the RAMLAB network.

1.2. Research Question

In this thesis the RAMLAB network will be researched, based on governance and innovation literature. The aim is to find out what actually leads to successful collaboration within the network, what the network members consider as most important and whether these factors correspond to the literature or not. Which means that this is an evaluative research. The following question has been drafted to serve as a guideline for this research:

‘Which factors influence the experience of good collaboration of a network situated in an innovative context, and which of these factors can be seen as most influential?’

To answer this research question the following sub-questions are constructed:

1. What does the theory say about good collaboration and which factors are seen as important?
2. What does the network of this case study look like?
3. To what extent is good collaboration experienced in this case?
4. To what extent are factors that, according to the theory, influence collaboration, present in the case?
5. Which of these factors contribute the most to the explanation of the degree of (good) collaboration in this case?

1.3. Research Objectives

This research consists of multiple interesting angles of approach, beginning with the fact that this is a relatively new composed collaboration. RAMLAB initiated in 2015 and expanded its network and

collaboration since then. However, success was particularly quickly achieved, to the surprise and satisfaction of many. But what exactly was the cause of this? Are there specific conditions that drove the network in the right direction? If so, how can this network hold on to this and continue the same way? Which factors must be maintained and what should be managed? It is especially interesting to look at this since WAAM activities and 3D printing are not the main business activities of involved actors; why are they interested and why do they invest their resources in a business that is not their core activity? This research aims to answer these questions.

It is interesting to look at this network from a governance network perspective. The past decades public sector theories have increasingly been paying attention to network collaboration. Theories about network compositions, their structure, relevant factors on collaboration and how to govern and manage them have led to significant considerations. Applying these theories to a specific case, the RAMLAB network, provides potential insights about their practical relevance. On the other side, it is also interesting to look what if there are factors that didn't receive enough attention yet.

In addition, the RAMLAB network consists of heterogeneous actors, public but mainly private actors that collaborate and exchange knowledge and resources to achieve their goals, based on innovative principles. Innovation can therefore also be considered as a guideline within the network. There is a significant quantity of research about innovation and innovation networks, both in private as public literature. Therefore this thesis will look not only at literature on governance networks, but also at innovation networks and compare these research areas. As a result, the RAMLAB network will be examined with a broader view, both network types shall be studied and features that are most prominent in the RAMLAB network will be examined.

The intention of this master thesis is to provide insights on both innovation networks and governance networks, focused on the RAMLAB network. The focus lays on exploring factors that influence collaboration in networks, the degree of collaboration and what network members perceive as significant elements for the well-functioning of the networks. Multiple causes (strategies, conditions, incentives etc.) will be examined and an overview will be presented.

1.4. Relevance

1.4.1. Societal Relevance

The societal relevance of this thesis exists on multiple levels. First of all, this research contributes to the general knowledge and insights of cooperation and governance. It sketches a picture of a relatively new type of collaboration that takes place in the innovative sector. Other start-ups or similar networks can learn from this and possibly improve their cooperation thanks to the contribution and insights of the respondents of RAMLAB on good collaboration. The fact that interdependencies between organizations are expected to increase and the demand for this type of cooperation grows, makes knowledge of governance and network collaboration all the more relevant. Then, this research is also relevant for the founders of RAMLAB (Innovation Quarter, The Port of Rotterdam and RDM MakerSpace), because an evaluation of the network is carried out without the emphasis on results or production of the network, which can provide new insights. Furthermore, the RAMLAB network is, as a result of this research, more informed about what, by its own members, is experienced as good collaboration. Insights about which factors truly contribute, what is considered important and where there is room for improvement are retrieved. In addition, network members also gain insights on how their co-members experience the collaboration. It is now possible to see similarities and differences between their opinions, to discuss these, and this research may also contribute to better cooperation between the RAMLAB network.

1.4.2. Scientific Relevance

The scientific relevance of this paper follows from the aim to add to the body of current knowledge on innovation and governance networks, good collaboration and corresponding conditions. This has been attempted in a number of ways. At first, collaboration and innovation in the public sector are both increasingly popular subjects by academics. The idea that innovation must take place within organizations loses its power, now the emphasis is on innovation as an open process between stakeholders of different organizations. This new open, collaborative perspective is embraced in the field of innovation, but there is still room and need for insights how network governance, collaboration

and management take place in this composition (Bekkers & Tummers, 2018). This research is looking at this, echoing the desire from the academical field. Furthermore, much research on public sector innovation remains theoretical and inductive, whereby theory is built instead of tested. There is a demand for looking with a deductive perspective, and that is exactly what this thesis does. It tests governance literature on an innovative network and examines whether this theory corresponds to practice, here a case study. It is acknowledged that findings cannot be generalized, since it is only one case, but it does contribute to the deductive knowledge. An attempt has also been made to bring the gap between these departments closer together. And at last, there is also a significant learning element for the public sector. Most literature about innovation networks is carried out in the private sector. There is a lot still unknown about innovation networks and which role, and to what extent, governance and governance networks play there (Mazzucato, 2011; Morrar, Gallouj & Hammadou, 2012). In-depth knowledge about innovation networks is lacking in the public sector (Koppenjan, Cao & Marks, 2019). This thesis attempts to minimize this gap. But the learning element also works the other way around; theory and knowledge from the field of public administration is linked and applied to the innovative sector, where improvement and learning can originate from.

CHAPTER 2: THEORETICAL CHAPTER

The aim of this chapter is to answer the theoretical research question of this thesis: *'What does the theory say about good collaboration and which factors are seen as important?'*. The central concepts of this research are set out in this theoretical chapter. This chapter is constructed as following: it starts with the phenomena of governance networks, what are the characteristics, how collaboration shapes itself within governance networks and what network management does entail. After discussing governance networks, innovation networks shall be elaborated. Reason for this is because we are looking at an innovative network (RAMLAB). We need knowledge of both governance and innovation literature, so this can complement each other and creates a good basis for this research, and it means that we can answer the research question as well as possible. When discussing innovation networks, we also look at its characteristics, collaboration within those networks and conclude with network management within innovation networks. The chapter closes with a conceptual framework and its related concepts.

2.1. Governance Networks

In this section governance networks are elaborated. Before the characteristics of governance networks will be amplified, the historical context of public administration shall be explained briefly. This is to get a better understanding of the public sector.

Traditional Public Administration

Public administration has a long history. Administrative systems already existed in ancient Egypt in times of the Han dynasty, in the years 206 BC to AD 220 (Hughes, 2003). Despite this, most public sector academics begin their public administration timeline with the paradigm of Traditional Public Administration (TPA). TPA developed itself late nineteenth century and reached its peak in the welfare state era of 1945-1970 (Osborn, 2007). Typical for this way of administrating is the focus on a central role for the Big Government, with a big bureaucracy and standardization of work ('one best way of working'), a dominant 'rule of law' and with preference for the implementation cycle, task differentiation and standardized procedures. The strategy they enhanced was state centred, the problems they encountered were perceived as stable, so problems could be attended with a straightforward, defined and fixed manner (Hartley, 2005). Weber, Wilson and Taylor are well-known persons in this paradigm, all applauding this paradigm for bringing more stability, efficiency, control, uniformity and continuity. Especially when you keep in mind that public administration before TPA most often was organized around nepotism or patronage (Hughes, 2003). However, problems with this paradigm became increasingly visible and critic rose. Problems related to incoherently policies and governing, difficulties with controlling budgets, coordination of units from the centre and delivering integral services increased, especially with a society that became more pluralistic and dynamic (Klijn & Koppenjan, 2016). TPA became seen as inefficient, costly and inflexible. There was a demand for a new way of governing, and NPM had to give space to the next dominant paradigm of public administration: New Public Management (NPM). Notwithstanding the fact that TPA is seen as out-dated, you can still see lots of TPA characteristics in current policies, for instance how citizens have to apply for a passport.

New Public Management

New Public Management is introduced as a reaction on the shortcomings of TPA, from late 1970s on. Private-sector management techniques were introduced in the public sector, focussing on outcomes, efficiency and effectiveness. Input and output control, evaluation and performance criteria were emphasized, a growth in the use of competition, contracting and market forces are basic concepts of NPM (Osborn, 2007). Additionally, there was a shift to privatization and quasi-privatization, hands-on professional management, standards and measures of performance and a stressing discipline in resource use (Hood, 1991). Where TPA viewed their context as stable, NPM sees the context they work in as competitive. Problems and needs of citizens are seen as wants, and due to market forces, most needs of citizens are fulfilled. Governing happens through the mechanism of purchasers and providers and citizens are seen as clients or costumers and public servants as public managers. NPM focusses on the public choice instead of the TPA public goods (Hartley, 2005). NPM emphasizes on disaggregation, where it combined vertical specialization with horizontal specialization (single-purpose organizations),

resulting in 'role purity', also acknowledged as fragmentation of the organization (Christensen & Laegried, 2010). NPM also received its certain amount of critic, mostly about NPM increasing institutional and policy complexity, that it generates adverse by-product outcomes and focussing too much on outcomes, whereby the focus on the process and content gets lost, problems with contracting out and losing public value and interest out of sight and the decreasing effects of NPM on public accountability. Some say this led to the end of the NPM era (Dunleavy, Margetts, Bastow & Tinkler, 2006). Likewise the TPA, still a lot of characteristics of NPM are visible in society nowadays, especially in countries that are less industrialized, NPM is still growing, but also in post-industrialized countries NPM has left its mark.

After the NPM multiple academics see Governance Networks, New Public Governance, Interactive Governance, Meta-governance or Digital-Era Governance as the next dominant paradigms (Osborne, 2006; George & Desmidt, 2014; Grotenberg & Altamirano, 2017; Edelenbos & Van Meerkerk, 2016; Klijn & Koppenjan, 2016; Sørensen, 2006). Bluntly, what they all have in common is their focus on collaboration and governance. It is too early to say which of these paradigms shall dominate, and there is also the option of the paradigms to live side by side or to complement each other. Especially since there are major similarities between some and some even are quite the same but are called differently. In this thesis the focus lays on governance networks, for the reason this thesis concentrates on networks and therefore this choice is justified. What governance networks exactly are, will be examined in the next paragraph.

2.1.1. Characteristics of Governance Networks

In the former, we have seen that the transition from one paradigm to another came (among other things) as a reaction on pitfalls of the prior system. Governance has emerged on one hand as a response on failures of NPM (and TPA), and on the other hand as a reaction on changes in society and the context of the public sector. Suggested developments by academics are for instance that the state has become fragmented, (too) specialized and multi-centred, and that the distance between government and society has become vague, the line between them is blurred (Sørensen, 2006). Additionally, governance and collaboration arose because of failures with implementation, high costs of bureaucracy, regulation and accountability. Society becomes more pluralistic and divergent, and collaboration is seen as necessity because of the rise in specialized knowledge and institutional capacity, which results in interdependencies, more complexity and a demand for sharing of knowledge and expertise (Ansell & Gash, 2007).

The rise of complexity in society is a large field of research in public administration, leading to complexity theory and complex system thinking. These concepts consider society nowadays as a world *"that consist of multiple elements, from different classes that are related, but sometimes loosely, and whose mutual relationships are changeable over time. [...] The complexity of this world arises from the fact that the world is an enormously diverse place where local interactions between elements always render new and different outcomes"* (Gerrits, 2012, p. 16). Arnold & Wade (2015) add that complex systems increasingly arise, encouraged by globalization, nations that come gradually more interconnected, a higher level of technological advancement and feedback loops that interact with different systems around the world. Systems become more and more interconnected, which again results in more complexity and unpredictability. But what exactly is complexity and what are the problems for the public sector that result from this complexity and intertwined, unpredictable systems?

Complexity is more than difficult or complicatedness. Complex problems are understandable but require time and energy before they are understandable. For tackling this kind of problem, you have to understand the local conditions and context, wherefore you can understand the dynamic patterns of the system. Their cause-effect relationship is not repeatable or non-linear, nor predictable or generalisable, which results in difficulties (Martin & Sturmberg, 2005). Adding to this, complexity is often seen as 'self-propelling'. Which implies that complexity generates even more complexity and this in an invincible way (Gerrits, 2012). A growing number of the societal issues we are facing nowadays are highly complex and challenging. In the public administration-literature they are often called 'wicked problems'. Wicked problems are difficult to define, have no clear or true solution, are multi-causal, consist of interdependencies, need in-depth knowledge, involve various actors with several (diverging)

perceptions and are socially complex (Rittel & Webber, 1973; Sherman, 2016). The more diverse and complex the problem is, the wickeder the problem (Head & Alford, 2015).

Complexity and wicked problems cause acting and decision-making in the public sector to be more difficult. Due to the complexity of the world, public decision-makers have to work in a field where they are subjected to unforeseen and unintended effects and to dynamics occurring anywhere, what happens at the other side of the world can have influence on the world and outcomes of policy here, also called 'the butterfly-effect' (Gerrits, 2012). The way problem-solving and decision-making (governing) is organised, is significantly changed by this. Tackling complex and wicked problems often requires multiple actors, since one actor often cannot provide the necessary resources and capacities by themselves. Here you see an upcoming demand for collaboration, a more horizontal cooperative way of working, for governance. This, in combination with higher interdependency and frequent interactions, results in the emergence of networks, the so-called governance networks (Klijn & Koppenjan, 2016).

Definition of Governance Networks

From the forgoing follows that a demand for collaboration and networks arises since the end of the twentieth century. Thereby the role of the government is subjected to change as well. From the central, big government in the TPA era to the managerial public sector in NPM and in GN you see a change from government to governance. But what exactly does governance entail?

In the literature various explanations and definitions are given of governance. Ansell & Gash (2007) argue that governance "*is about collective decision-making that includes both public and private actors*" (Ansell & Gash, 2007, p. 545). Sørensen (2006) sees governance as "*a complex governing process in which a multitude of public and private actors interact to govern society*" (Sørensen, 2006, p. 99). Schmitter (2002) argues that governance refers to "*a method/mechanism for dealing with a broad range of problems/conflicts in which actors regularly arrive at mutually satisfactory and binding decisions by negotiating with each other and co-operating in the implementation of these decisions*" (Schmitter, 2002, p. 52). Stoker (2004) sees governance as "*the rules and forms that guide collective decision-making. Governance is not about one individual making a decision, but rather about groups of individuals or systems of organisations making decisions*" (Stoker, 2004, p. 3). Provan & Kenis (2007) see governance as "*the use of institutions and structures of authority and collaboration to allocate resources and to coordinate and control joint action across the network as a whole*" (Provan & Kenis, 2007, p. 231). Recurring elements of governance are that more than one actor needs to be involved in the process, that these actors circle around a problem or resources and that there are institutions (rules, forms or structures) that shape this process.

Now that an idea of governance is conducted, a definition of networks and governance networks shall follow. In its most broad definition, a network is whenever two or more actors communicate (Technopedia, 2019). Provan & Kenis (2007) define 'network' more narrowly. A network consists of "*three or more legally autonomous organizations that work together to achieve not only their own goals but also a collective goal*" (Provan & Kenis, 2007, p. 231). The concept of 'governance network' is more difficult to define. Development on policy and governance network theories began in the 1990's. Academics emphasised the emergence of self-organising capacity of actors and networks when resource exchange becomes increasingly necessary to make progress and solve (complex and wicked) problems. Dependencies on each other's resources can result in interdependencies, which require actors to collaborate and interact more frequently. Interactions in those networks often show durability, which result in perceptible interaction patterns. Characteristics of governance networks are endorsed by multiple academics, for instance as Agranoff & McGuire (2003), Sørensen & Torfin (2007), Hanf & Scharpf (1978) Kickert, Klijn & Koppenjan (1997a) and Koppenjan & Klijn (2004). They emphasize the heterogeneous composition of the network, often with a high diversity of actors and pluralism in interactions, power distribution and resource input. The aim of governance network is to find common interests, to realise stability in relationships and to find a shared understanding in how goals should be achieved (Gerrits, 2012). This is not easy to achieve, especially not when considering the complexity and wicked problems those networks are often facing. They require collective action of multiple actors, since it is in certain circumstances extremely difficult to solve problems alone. Interdependencies arise, even as intertwined interaction patterns.

Kickert et al (1997a, p. 10-11) set out different features of a network perspective, which makes it easier to understand governance networks and their context. In the network perspective, and for governance networks, success is defined by the realization of collective action. Failure is caused by a lack of incentives for collective action and can be reduced by network management that focuses on improving the conditions and incentives and decreasing existing blockages. The role of the network manager is to mediate, shape the network and manage the process, which implies guiding interactions and providing opportunities. Relations within the networks are seen as interdependent, whereby the policy process consists of an interaction process of resource, information and goal exchange (Kickert et al, 1997a). The combination of the aforementioned characteristics of governance networks and the characteristics of the network perspective lead to the following definition of governance networks by Klijn & Koppenjan (2016, p. 11) “*more or less stable patterns of social relations between mutually dependent actors, which cluster around a policy problems, a policy programme, and/or a set of resources and which emerge, are sustained, and are changed through a series of interactions*”. In summary, this leads to the following definition, that it is embracing all said beforehand: a network of interdependent actors, who exchange resources and try to influence, steer and use strategies, which cluster around problems, programmes or sets of resources, who emerge, are sustained and changed through interaction.

It is argued that to tackle wicked problems and the complexities governance networks need well-functioning collaboration and network management. These two subjects will be elaborated, starting with collaboration.

2.1.2. Collaboration within Governance Networks

Building further on the former and for answering the research question, it is important to know what collaboration exactly entails. Ansell & Gash (2007) did a meta-analytic study on collaboration within policy making and public management. Their findings have led to the following model: ‘A Model of Collaborative Governance’, see Figure 1. The basis of this model is collaboration and is structured in a number of variables: ‘starting conditions’, ‘institutional design’, ‘facilitative leadership’ and the ‘collaborative process’. This model and the related variables form the basis of this this thesis. The variable ‘outcomes’ is not included in this study, in light of the fact that the focus of this thesis does not include outcomes of the network but is focussed on the collaboration itself.

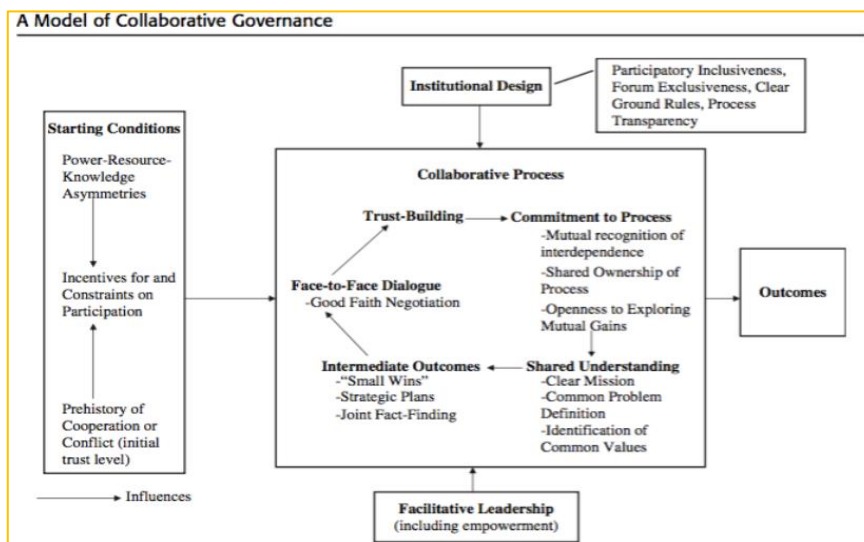


Figure 1: A Model of Collaborative Governance, Adopted from Ansell & Gash (2007).

Collaborative Governance

Since this model is called ‘collaborative governance’, it is important to know what this is. Ansell & Gash (2007) define collaborative governance as “*a governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal,*

consensus-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets" (Ansell & Gash, 2007, p. 544). Collaboration is necessary in the collaborative governance process and actors (public and non-public) work collectively to establish goals (Stoker, 2004). This way collaboration implies a two-way communication and consists of a deliberative and multilateral process (Ansell & Gash, 2007).

In the following sections the variables of the collaborative governance model are briefly examined. Besides the knowledge of Ansell & Gash (2007), also insights of other research are added to the variables. Facilitative leadership shall be treated more extensively, since management in the private sector, network management and leadership in the public sector plays a big role in scientific literature.

Starting Conditions

Starting conditions play a role in facilitating or discouraging collaboration in the initial phase of the cooperation. The prior history between actors may influence their present and future behaviour. As you can see in their model, three critical conditions are mentioned by Ansell & Gash (2007): imbalances between power or resources of the actors, incentives or limitations to collaborate and the past history of cooperation or conflict.

Starting with the first condition, if there is a big difference between the input of resources of actors, the collaboration process is submissive to manipulation by the actors that bring more on the table. This imbalance can lead to power differences, which may result in powerful actors influencing decision-making (Ansell & Gash, 2007; Gray, 1989; Gerrits, 2012). The second condition concerns the participation in collaborative networks (or governance networks), which often happens on a voluntary basis. The attractiveness of incentives plays a significant role if actors will join the network or not. Expectations such as meaningful outcomes of the collaboration, are clearly present by making this choice, but also the consideration between costs and benefits. The third starting condition concerns the prehistory of collaboration between the involved actors. A negative association between actors hinders future collaboration and positive associations have a fostering function. Because of the high interdependency within the network, a high level of (pre)conflicts may influence the decision to join or not join the network, while a successful history leads to high levels of trust and influences incentives the positive way (Warner, 2006; Ansell & Gash, 2007).

Institutional Design and Rules

The institutional design consists of the ground rules and basic protocols for collaboration. This is important for the collaborative process' legitimacy (Ansell & Gash, 2007). Institutions "*shape actors' behaviour through formal as well as informal means; they exhibit dynamism as well as stability; they distribute power and are inevitably contested and are mutually constitutive with actors whom they influence, and by whom they are influenced*" (Lowndes & Roberts, 2013, p. 45). The institutional characteristics of a network come from the exchange of the historical aspects of actors, their formal and informal rules, patterns of interactions, patterns of perceptions and trust among actors (Klijn & Koppenjan, 2016). Institutional design involves institutional creation, which is an on-going commitment to enforce rules, practices and stories by the network members (Lowndes & Roberts, 2013).

Ansell and Gash (2007) distinguish four institutional characteristics that contribute to a better collaborative process, namely: participatory inclusiveness, forum exclusiveness, clear ground rules and process transparency. When considering participatory inclusiveness, you have to think about how including your network is and how accessible it is to participate. The more inclusive, the more stakeholders who are involved or affected by the specific issue or subject are able to participate in the network. A broadly inclusive network is seen as a condition for successful collaboration and broad participation should therefore be sought (Gray, 1989). When the design is open and inclusive this leads to higher participation, which again results to more commitment to the process and collaboration (Ansell & Gash, 2007). Actively excluding stakeholders is seen as a factor of failure and can threaten the legitimacy of the process (Reilly, 2001). The second factor, forum exclusiveness, is about the exclusiveness of the network; about being the 'only player present in town' and being the only source, so alternative forums are limited or non-existing. When the forum is exclusive, stakeholders sooner participate in your network and alternatives for realizing their agenda somewhere else are limited. So, when there is a high participatory inclusiveness and a high forum exclusiveness, stakeholders are not

likely to seek alternatives (Ansell & Gash, 2007). Then, the third institutional characteristic is that having clear ground rules in your network results in higher procedural legitimacy and trust building. When the basic principles are clear to stakeholders, and they are consistently applied, it reassures them that the process is fair, equitable and open (Murdock, Wiessner & Sexton 2005). The last institutional factor concerns process transparency. This means mainly that negotiation and conversation does not take place behind closed doors, but that stakeholders experience the process as 'real' and are able to see the whole process with certain clarity (Ansell & Gash, 2007).

Collaborative Process

The collaborative process is considered a cyclical or iterative process, instead of a linear one. The reason for this is the influence of feedback from earlier collaboration and feedback loops from the environment on current collaboration, which causes it to be cyclic. The collaborative process of governance networks are consensus-oriented where communication between actors is necessary to identify opportunities for mutual gain (Bentrup, 2001). Ansell & Gash (2007) imported five variables into their model concerning the collaborative process, which are: face-to-face dialogue, intermediate outcomes, trust-building, commitment to the process and a shared understanding. Together they contribute to a better involvement of the collaborative process.

Starting with the variable face-to-face dialogue. Dialogue is a process that involves listening, exploring ideas and finding common ground. It is a means to foster mutual insights and to find common purpose (London, 2019). Dialogue helps “*breaking down barriers, building trust and mutual respect, shared understanding, and commitment to the process*” (Ansell & Gash, 2007, p. 558). Whenever the norms and values of good faith negotiation form the basis of face-to-face dialogues this contributes to a successful collaborative process. Negotiating in good faith means to act honestly and fairly, where benefits are mutual, an effort is made to reach common ground and negotiations are likely to result in an agreement (Shonk, 2019; O’Neill, 2001).

The second variable concerns intermediate outcomes. When potential goals are concrete and small wins show that they are within reach, it is more attractive to participate in the collaboration. Providing strategic plans and conducting joint-fact finding contribute to this (Ansell & Gash, 2007). Joint-fact finding is a method that allows actors to work together on knowledge development. It is a process of receiving information, discussing it, complement it with more knowledge and re-discussing it. The aim is to arrive at a shared perception of knowledge, which can serve as basis for policy development and decision-making (Erhmann & Stinson, 1999).

Then, the third variable is trust-building. Trust is the expectation that “*the other actor refrains from opportunistic behaviour even if the opportunity for it arises without having any guarantee that the other party will indeed act as expected*” (Klijn et al, 2010, p. 195). Trust has several benefits on collaboration and networks, also for achieving better network outcomes. Trust reduces risks and (transaction) costs, leads to more predictability and stability and stimulates knowledge exchange and organizational learning. This results in more and better interaction, enhanced problem-solving capacity, which again results in better solutions and collaborative outcomes (Fukuyama, 1995; Nooteboom, 1998; Sørensen & Torfing, 2007). Reason for the significant role of trust in governance is the important role trust plays in highly uncertain and complex contexts, which we now know is a characteristic of governance networks. However, trust is not built overnight. It requires long-term commitment and is time-consuming, but the importance of trust-building is frequently emphasized in the literature and therefore an important variable (Ansell & Gash, 2007).

Furthermore, the fourth variable, commitment to the process, is seen as a critical variable for success or failure of the collaborative process and is considered to facilitate the process. When there is commitment to the process, actors “*develop a belief that good faith bargaining for mutual gains is the best way to achieve desirable policy outcomes*” (Ansell & Gash, 2007, p. 559). There are three conditions that contribute to commitment, namely: mutual recognition of interdependence, shared ownership of the process and openness to exploring mutual gains. A first step that can be taken towards commitment is the mutual acknowledgment of interdependence within the network. Interdependency is the state of being mutually reliant on each another (Lusch & Brown, 1996). When people recognize their interdependent status, this encourages a desire to contribute and to commit to meaningful cooperation. Additionally, when you acknowledge your interdependence, you easier realize that there is something

to be gained together. Therefore it is easier to explore mutual gains, which enhances commitment. Also increased involvement contributes to commitment. Another reason why actors can experience more commitment results from the shift to shared ownership of the process. In collaborative governance, decision-making does not lie with one actor or organization, but collectively by the actors. This implies a shared responsibility for the process and therefore more pressure on the mutual trust relationships between the actors. You have to trust one another when sharing responsibility. Trust and commitment are strongly related. In addition to the foregoing, actors have to trust that their perspectives and interests are respected, the procedure is fair, integer and transparent and that other actors will not show opportunistic behaviour to the detriment of them. If this is truth, actors easier commit themselves to the process and to the collaboration (Ansell & Gash, 2007).

And at last, the fifth variable is about accomplishing a shared understanding between the actors. When arriving at a shared understanding, shared vision, or shared ideology actors have found an agreement on a problem definition or the necessary knowledge for tackling a problem. Defining a clear mission and identifying common values between actors is part of working towards a shared understanding (Ansell & Gash, 2007). Actors need a vision of what they can possibly achieve because of their collaboration. Stating a clear mission enhances this, even as finding a common problem definition and the identification of common goals. The road to this can be seen as a collaborative learning process (Burger, Gochfield, Powers, Waishwell, Warren & Goldstein, 2001).

Concluding, these five variables have a positive relation with a good collaborative process. When they are positively present, they have a positive effect on the collaborative process, and, a well-considered collaborative process seems promising for networks. It has multiple benefits, such as avoidance of high adversarial policy making costs, restore the rationality of public management and increase democratic participation. Besides, the model of collaborative governance has the practical influence that network agents take contextual conditions under consideration and see if this enhances or reduces desired outcomes (Ansell & Gash, 2007). However, collaborative governance is a demanding process that must be actively maintained, it is not self-explanatory which must be taken into account.

Network Management within Governance Networks

The last characteristic of the model of collaborative governance concerns facilitative leadership. Facilitative leadership corresponds to network management. Network management, management and leadership are important concepts in the public administration literature, which is why this is discussed in detail in the following section.

Most management theories rely on the assumption that organizations desire to achieve goals, by means of resources, such as human, technological, financial and natural. To realise those goals effectively, management is necessary; which involves organizing, staffing, directing, planning, budgeting, coordinating and reporting. Now that there is a trend towards more collaboration, governance and networks, there is also a demand for more suiting managements abilities and activities (Van Wart, 2013; Gulick & Urwick, 1987). One of those demands is the need for network management (Murphy, Rhodes, Meek & Denyer, 2017). This is supported by the thought that existing leadership strategies cannot cover today's complex environments and challenges. But: what is network management?

Network management is simply said the management of a network. It is the coordination of strategies in a network, where actors with different goals regarding the same problem or policy congregate (Kickert, Klijn & Koppenjan, 1997b). Klijn & Koppenjan define network management as "*all the deliberate strategies aimed at facilitating and guiding the interactions and/or changing the features of the network with the intent to further the collaboration within the network process*" (Klijn & Koppenjan, 2016, p. 11). Network management is seen as a form of (indirect) steering, that focuses on dealing with complexities and uncertainties by influencing strategic actions of actors and the network.

The importance of management is endorsed in the literature. It is emphasized that complexities can be tackled by well-functioning management and that the collaborative process performs better if the network is properly managed. Management can have a bigger influence on network performance than, for example, structures, processes and contextual factors of the network (Lewis, Ricard & Klijn, 2018)

Research shows a large number of management activities that contribute to a better functioning network; frequently recurring topics are facilitating and guiding the interaction processes, steering of strategic actions and creating consensus for finding a common ground and building trust (Chrislip & Larson, 1994; Reilly, 2001). More specific, network management is important for empowering, embracing and involving actors within the collaborative process (Vangen & Huxham, 2003). It is critical for bringing actors together and for providing an arena where actors can search for opportunities and mutual gains (Kickert et al, 1997a). In addition, the creation of an institutional design, where rules are set and maintained to ensure an integer process and network arrangements are created improve the coordination of the network is also an important management task (Klijn, Edelenbos & Steijn, 2010). By mediating and guiding the strategic actions of the network, opportunities arise for goal searching and finding a common purpose (Termeer & Koppenjan, 1999; Klijn & Tijmsman, 1999). A well-coordinated interaction process enhances trust within the network and, as stated before, trust is an important link in a well-functioning collaborative process (Ansell & Gash, 2007). Therefore, trust-building is an important task for network managers. It is assumed that without trust actors will refrain from interaction and performing in the network, and increasing trust levels have several beneficial effects. Trust results in more predictability and stability in the network, which reduces uncertainties, (transaction) costs and risks. It stimulates learning and resource exchange, which again increases the outcome of better solutions and stimulates innovation (Fukuyama, 1995; Nooteboom, 1998; Sørensen & Torfing, 2007). The impact of management strategies on trust is that the more trust-building strategies are used, the higher the level of trust (Klijn et al, 2010).

A network is managed by a network manager. A network manager can be seen as a mediator, a network builder and a process manager (Kickert et al, 1997a). Network managers seem important for the (collaborative) process, the outcomes and network performance (Van Meerkerk & Edelenbos, 2014).

An essential skill of the network manager is to bring and maintain a certain amount of stability in the network in order to structure, coordinate and control (Murphy et al, 2017). Network managers are important for creating consensus, for empowering and representing stakeholders within the network and to distribute and balance power and resources in a fair manner. Lasker & Weiss (2001) state that network managers must have the skills to promote broad and active participation, ensure broad-based influence and control, facilitate productive group dynamics and extend the scope of the process (Lasker & Weiss, 2001, p. 31 in Ansell & Gash, 2007). In addition, network management must encourage participants of having an open attitude to each other's perceptions, stimulate creativity and synthesizing, use transformative techniques and explore potentials for mutual gain.

There are several leadership (management) styles distinguished. It is interesting to see if you see differences in literature in terms of what management and managers have to perform if you look at the person (the manager) instead of the process (the management). What stands out is the fact that strategies of network managers are much more specific. However, there is a large similarity between them. Once again you see a focus on facilitating the interaction process, the steering of actions and finding common ground, only now more specifically applied. Murphey et al (2017) make a classification of leadership styles in complex environments. For that reason this specific classification will be used in this thesis, because of the context in which governance networks are often positioned. They make a distinction between administrative, adaptive and enabling leadership, and have linked certain management strategies to each form.

Administrative leadership pays attention to stability and control in a formalized way. Authority and decision-making are structured, even as standardized planning, structuring and coordination. The linked management strategies are “*directing, planning and resourcing activities, creating clear lines of authority, roles and responsibilities, and integrating and embedding innovation into the formal system*” (Murphy et al, 2017, p. 695).

Adaptive leadership is more informal compared to administrative leadership. This form of leadership pays attention to creating and developing new solutions that respond proactively to the adaptive needs of an organization. Its strategies are focussed on creating context for innovative ideas and new ways of working. The linked management strategies are “*stimulating innovative ideas and new ways of working, actively supporting inclusion of diverse skills and perspective (boundary spanning) and changing plans, processes and routines*” (Murphy et al, 2017, p. 695). Boundary spanning is done

by network managers who push the boundary between organizations and their environment. They try to bridge the organization and environment by connecting and binding people and organizations. To be successful as a boundary spanner, it is important to be strongly connected on the internal and external boundary of the organisation or network. This way they can collect and transform information from inside and outside their own network or organization. The most significant action of boundary spanners is connecting different actors and their perceptions and interests. This leads to the emergence of trustworthy relationships, which again results in an improved network performance (Van Meerkerk & Edelenbos, 2014).

The third and last form Morrar et al (2017) mention is enabling leadership. This leadership style is often used in a context that is both formal organized as taking place in a complex, adaptive environment. A balance must be found between the various characteristics within this context, and that is the network manager his role. Management consists of choosing and finding balance between certain strategies, for instance “*giving meaning to events (sense making) vs. disrupting existing patterns and assumptions*” or “*coordinating and formalizing networks vs. facilitating and enabling informal networks*”, and “*removing, excluding or alienating dissenting actors vs. protecting actors from external politics and top-down directives*” (Murphy et al, 2017, p. 695).

When looking back at the beginning of this chapter we have started with a little introduction on public administration and its two main approaching (TPA and NPM) and the run-up to governance networks. The concepts of governance, networks and governance networks were introduced. The definition of Klijn & Koppenjan (2016) was followed, seeing governance networks as patterns of social relations between interdependent actors, who cluster around policy or resource, and change through interaction. After discussing the characteristics of those networks, the collaboration of governance networks was discussed. Here, the model of Ansell & Gash (2007) was introduced and its four variables of collaborative governance were elaborated. Which regards starting conditions, the institutional design, the collaborative process and facilitative leadership. Facilitative leadership, which also can be seen as network management, has been treated more extensively, since literature indorses its role on good or successful collaboration.

2.2. Innovation Networks

In this paragraph innovation networks shall be discussed. Starting with characteristics of innovation networks, consisting of a definition of innovation networks, their structure, as well as relevant perspective on innovation networks. Thereafter collaboration within those networks shall be explained, containing of concepts of open innovation and triple helix networks. This paragraph shall conclude with network management within innovation networks and most relevant strategies will be emphasized.

2.2.1. Characteristics of Innovation Networks

As said in the former, a growing number of problems in society can be characterized as wicked problems. Those highly complex problems occur in both the public as well as the private domain. Organisations dealing with high complex technologies encounter difficulties concerning the increasing demand of technological expertise and knowledge, high cost of innovations and investments, a fast pace of successive developments, required resources and a need for interdisciplinary and transboundary knowledge sharing (Koppenjan et al, 2019). Often one organisation alone does not possess this demand of divergent resources, when internal resources cannot meet the demand, a demand for external resources is growing. This, in combination with technological, strategic and institutional uncertainty results in a growing demand for pooling of resources and trustful collaboration. Collaboration between and with other actors is an increasing necessity in the field of technology, research and developments (Kuppers & Pyka, 2002; Chesbrough, 2003). Just like the general trend that collaboration is increasingly taking place in networks, this also happens when innovation is involved, resulting in innovation networks (Li, 2019). Innovation networks contribute to pooling complementary resources, managing technological uncertainties and they reduce the costs of developments and research (Sydow & Müller-Seitz, 2018). But, what do innovation networks entail exactly?

Definition of Innovation and Innovation Networks

Step one in defining innovation networks is to know what innovation exactly entails. The British encyclopaedia defines this briefly as: “*the creation of a new way of doing something*” (Boslaugh, 2019, p. 1). De Vries, Bekkers & Tummers (2015) did a systematic review on innovation in the public sector and perceived that in most research the definition of Rogers (2003) was being used, seeing innovation as “*an idea, practice, or object that is perceived as new by an individual or other unit of adoption*” (Rogers, 2003, p. 12). A more extensive definition is that “*innovation is the creation of new, technologically feasible, commercially realizable products, processes and organizational structures, emerges from the ongoing interaction processes of innovative organizations*” (Ahrweiler & Keane, 2013, p. 76). Lewis, Ricard & Klijn (2018) emphasize the importance of implementation of those innovative ideas, and also Hartley (2005) sees innovation as a process where new ideas should be translated in new practices of action. Braithwaite, Churrua, Long, Ellis & Herkes (2018) emphasize the fluidity, messiness and chaotic tendencies that innovative processes bring with them. Innovative process and outcomes are subject to variation, multiple pathways, unanticipated intermediate outcomes and conflicts. Merging this together may result in instability and unpredictability of the innovative processes.

Different types of innovation can be observed, such as product innovation (a new product), service innovation (a new manner of organizing services), process innovation (a new design of the organizational processes, methods and techniques), position innovation (new users or a new context for activities that already exist), strategic innovation (new strategies and goals for an organization), governance innovation (new forms and processes to address societal processes, possibly with new relations between stakeholders) and rhetorical or conceptual innovation (new concepts, frames, references, languages or paradigms) (Walker, 2014; Damanpour & Schneider, 2009). Especially the last three innovations differ between the public and in the private sector.

Multiple researchers find differences in innovation between the public and private sector. Hartley (2005) makes a distinction between innovation in the private sector and innovation in the public sector. Private sector innovation focuses primarily on competitive advantage, while the public sector is more driven by service performance and achieving widespread improvements in governance and public goals. Some academics state that innovation in the public sector is highly unlikely because of the absence of market forces and competition, the risk-averse culture and the public sector’s inflexibilities. On the other hand, stimulating characteristics of public sector innovation are also mentioned: a need for public institutions to meet citizen’s demands, having well-educated staff and having easy access to the most up-to-date available knowledge and information (Li, 2019).

The growing complexity and uncertainty shape innovation and how developing innovation takes place. For producing high-quality, innovative output, collaborative knowledge production seems the most promising manner to do this, and it has become the most dominant way of organizing it. Heterogeneous participants (often public and private actors) team-up along the process, collecting and connecting knowledge, resources and innovation (Bozeman & Lee, 2005; Ahrweiler & Keane, 2013). Innovation is more and more a collaborative initiative that increasingly takes place in collaborative arrangements, often characterized as networks: innovation networks (Li, 2019). What are innovation networks exactly?

Ahrweiler & Keane (2013) define innovation networks as networks “*that involve the interplay of people, ideas and organizations to create new, technologically feasible, commercially-realizable products, processes and organizational structures*” (Ahrweiler & Keane, 2013, p. 76). Gloor (2006) sees innovation networks as networks where “*competitive advantages are realized through the activities of these networks. The main functions found within any innovation network revolve around innovation, collaboration, and communication*” (Gloor, 2006, in: Bentivegna, 2014, p. 6). Pyka & Koppers (2002), for example, emphasize innovation through mutual learning as outcome of interaction patterns in innovation networks and Koppenjan, Cao & Marks (2019) underscore the realization of innovation because of inter-firm learning, complementarities and synergies. From most definitions follows that innovation networks are seen as an arena where patterns of interaction take place between heterogeneous actors, which results in innovation. The group of collaborating heterogeneous actors can, in addition to private firms and government agencies, consist of innovation centres, universities, educational and financing institutions, standard setting bodies and industrial associations (Morrar, 2015).

Furthermore, networks are characterised by the reason they are initiated in the first place: to require access to knowledge and resources that were otherwise unavailable (Powell, Koput & Smith-Doerr, 1996). The networks are recognized as relative open systems of innovation, non-linear models and are contribute in the field of complementary knowledge and technology (Leydesdorff, Rotolo & de Nooy, 2013). It favours inter-organizational collaboration and requires and corresponds with the idea of open innovation, whereby processes are opened up to a large group of actors. Innovation networks are mainly present in industries with a high degree of expertise, under conditions of strategic, institutional and technological complexity, uncertainty and risk. Risk can manifest itself in various ways such as financial risks, technological risks, market risks and in turbulent events. Therefore they require knowledge exchange, collaborative learning and cooperation (Morrar, 2015; Koppenjan et al, 2019; Li, 2019). The network of heterogeneous actors can be seen as the social base that provides structure for facilitating knowledge and information exchange, the interaction process and structure for interaction between the cognitive components of the network (Morrar, 2015). The collaborative relationships and interactions of the network members are seen as the steering forces of the innovation process and technological output.

The processes of innovation networks can be seen in a hyper-dynamic context, where social, cognitive and technological patterns of interactions are involved. Social capital improves collective learning, the exchange of knowledge and improves the relationship of the heterogeneous actors in the networks. In addition, the interactive process is seen as an evolutionary process, whereby the entry and exit of the network is dynamic with uncoupling ties and fragmentation of the processes from time to time (Granovetter, 1985; Morrar, 2015).

Li (2019, p. 4-5) summarizes the foregoing in three main features of innovation networks:

- [1] innovation networks are not homogeneous, but heterogeneous;*
- [2] an innovation network is dynamic; and*
- [3] an innovation network is full of risks.*

2.2.2. Collaboration within Innovation Networks

The innovative sector has generally a complex and expanding, sophisticated knowledge base with widely dispersed expertise. Increasingly reliance is found on inter-organizational collaborations, especially since collaboration enhances inter-organizational learning. Therefore innovation networks are also called ‘networks of learning’ by some academics. The mutual dependencies that actors have on one another are seen as the major forces of collaboration in innovation networks. These interdependencies involve risk sharing, pooling of complementary skills and resources, speeding up (innovation) processes and obtaining access to new markets with novel products or ideas. Consequently, networks serve as access provider to knowledge and resources that were unavailable otherwise. In addition, collaboration is seen as necessity for innovation networks for jointly assessing ambiguities and cost allocations (Powell, Koput & Smith-Doerr, 1996). The quality of innovation is dependent of the degree of active participation in the network, so a good functioning collaboration process with efficient interaction results in better innovation output (Li, 2019; Morrar, 2015).

Morrar (2015) has developed a conceptual framework that accounts for collaboration for public-private innovation networks. He positioned the structure of this framework in a complex, social, dynamic and interactive network structure, what desirably leads to better innovation outputs. See Figure 2 for his framework:

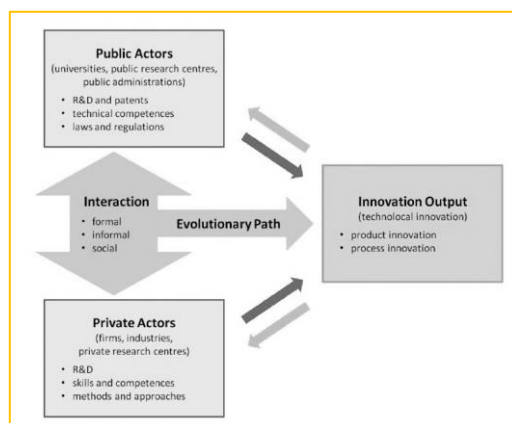


Figure 2. Conceptual framework of collaboration for private-public innovation networks, Adopted from Morrar (2015, p. 31)

In this model you see interaction taking place between public and private actors. During this interaction they exchange their resources, for instance “*research, development and patents, technical competences, laws and regulations from the public actors, and skills and competences, methods and approaches, and research and development from the industry*” (Morrar, 2015, p. 31). Taken together, the exchange and complementary relationship of complex knowledge and technologies between the involved actors. More specific, universities and research centres can construct and distribute scientific knowledge, with high levels of research potential and diversity. Universities play a fundamental role in the economic competitive of countries. In addition, universities are important for transferring know-how from the research field to the industry. The role of public administrations or agencies in innovation networks is to provide them with resources (for instance financial resources and subsidy), but also with governmental competences such as policy intervention tools, laws and legal capabilities (Morrar, Gallouj & Hammadou, 2012). Government roles can be co-existing and co-evolving in this type of collaboration. Private organisations can contribute with for instance their financial resources, specialised skills and competences, and their strive for progress and competitive advantages.

What shows great similarities with Morrar's model, but gives a bigger role to the academic sector, is the ‘triple helix collaboration’. Triple helix networks are innovation networks where collaboration takes place between the industry, government and the academic field (Etzkowitz, 2003). This network form is seen to improve the conditions for successful innovation, especially in a complex, knowledge-based society. It is argued that triple helix networks can be seen as innovation within innovation (Etzkowitz, 2003; Etzkowitz & Zhou, 2018). The idea behind triple helix networks is making the connection with fundamental research done by knowledge institutes and universities, and implies a broader and more active role for the academical sector.

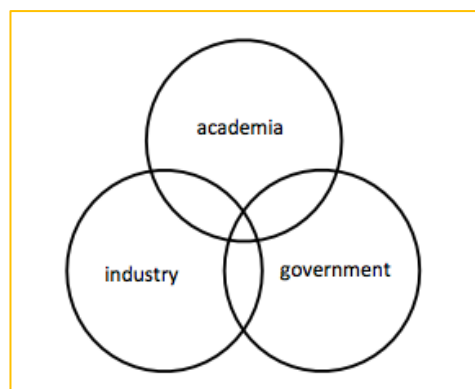


Figure 3. Triple helix model.

The underlying assumption of triple helix networks is that science and technology are increasingly important in a knowledge society, where economical and societal improvement is widespread encouraged and a shift from the dominating industry-government collaboration to a hybridisation of the three sectors. Innovation requires an increasing amount of knowledge, especially with expanding technological complexity and a complex context where innovation takes place. The public, as well as the private sector, tend as a result of these high technological levels to shift more and more to an academical model. Higher levels of training, knowledge, techniques and sharing of skills confirm the need for this shift to a hybridization of institutional background of the private, public and academical sector. The academical field is no longer only providing structure and support for the other sector, but gets more involved in, and has more influence on the processes (Triple Helix Research Group, n.d.).

The traditional structure of triple helix networks is as follows: the government functions as source for relations, concerned with providing stable interactions and exchange between actors, the industry is seen as the locus of production and universities and knowledge institutions the road to knowledge and technology. However, not everyone agrees with this structure, some say that they have taken each other's roles, even as they keep their primary identities. For instance, knowledge institutions take the role of the industry by 'capitalizing' their knowledge and as a sources of entrepreneurship, the industry tends more to the role of universities by training and educational programs and sharing of knowledge by varied forms of collaboration ('cognization of knowledge') and the public sector acts more as a public company that supports the collaboration through market forces (Etzkowitz & Zhou, 2018). What are the exact implications for collaboration in triple helix networks? Again, interdependency is a big promoter for this form of collaboration. It is widely recognised that science and technology are important for economic development and triple helix networks are a way to achieve this and to bridge the gap between knowledge and commercialization (Etzkowitz, 2003). Geerling-Eiff, Hoes & Dijkshoorn-Dekker (2017) find that for stimulating innovation in triple helix networks heterogeneous partners need to focus on building their relations, finding a joint vision and common ground. In addition, they state that in initial phases of the network ambitions should be tempered and not too ambitious, if not this would have opposite effects and counteract the process. They promote simple and flexible procedures, while building up the network and finding a common language, procedures can grow parallel with it and ambitions can be lifted to a higher level.

However, there is some criticism on triple helix networks. The network structure still represents a top down approach of innovation in a linear form of process (Etzkowitz, 2003). Important stakeholders and new developments of innovation processes are left out of this theory, because of the closed design. As said, great similarities can be found with the previous model of innovation networks of Morrar (2015).

The complementarity of the relations, as visualised in the model of Morrar and the Triple Helix model, provide an essential basis for good collaboration and a successful interaction process. This relation also works the other way around: good collaboration strengthens exchange of resources and interaction. Interaction and production of innovation output is a dynamically evolving process. There is no fixed role or function members have in the innovative collaborative process. The roles they adopt depend on their involvement and on the nature of the required resources, not on hierarchy or designated function (Morrar, 2019). The latter is confirmed by multiple academics that research innovation networks. Li (2019) states that most innovation networks are self-organizing networks, networks without a formal hierarchy, with autonomous members that often voluntarily join the network and share resources. Sydow & Müller-Seitz (2018) also follow this argumentation. They see innovation networks from a 'heterarchical open innovation'-perspective. Heterarchical means that the balance of power is neutral and the coordination and cooperation within a network arises equally. At one moment one network member acts as a leader, at another moment another member; there is no formal hierarchical control, but authority is distributed (Miura, n.d.). Collaborative decision-making is supported by governance structures and must lead to effective operating in the network (Sydow et al, 2012; Sydow & Müller-Seitz, 2018). The governance form related to this is meta-governance. Meta-governance is "*the regulation of self-regulation*" (Sørensen, 2006, p. 99). This is a way of governing that leaves autonomy for network members to govern themselves and has a plurality of indirect coordinating actions of the

network members (Sørensen, 2006). Meta-governing is seen as a way that fits the management of innovation networks, which will be discussed in the next paragraph (§2.2.3).

However, not everyone follows the argumentation of the changeability of the roles of network members. Dhanaraj & Parkhe (2006) see a certain division of roles in networks, because of the hub firms. In their ‘central orchestrator-perspective’, also called ‘hub firm-perspective’, a central network orchestrator undertakes activities to guarantee the creation of (innovative) value in the network. The network consists of active, rational network members, who take effective, calculated and determined actions and do not merely depend on incentives and restraints. The hub firm possesses certain importance and power that positions the firm as a central (key) entity, but it has no hierarchical authority, and therefore gives it a ‘subtle leadership’ position. This gives the firm a certain leadership role, what expresses itself in gathering the distributed competences and resources of network members, however it is subtle (Wasserman & Galaskiewicz, 1994; Dhanaraj & Parkhe, 2006).

Collaboration in innovation networks has its challenges. Actors run for example against the ‘innovator’s dilemma’, which means that processes are stuck and overcoming obstacles becomes difficult. In public innovation often the risk-averse nature of the sector is seen as difficulty, it delays or prevents a prosperous progress of the pooling of resources, consequently delays or prevents the innovation process. You can find a lot of similarities with challenges of collaboration in governance networks, such as substantive, institutional and strategic complexities (Klijn & Koppenjan, 2016). In addition, low levels of trust, unbalanced power relations, diverging and clashing perceptions, different and varied strategies are seen as challenges in collaborations of innovation networks (Fearman, McCaffrey & Van Slyke, 2001; Li, 2019). Trust is very important for innovative processes and networks, since the outcomes in innovation networks are not foreseeable. The risks are large (free-riding, opportunistic behaviour or cherry-picking) and benefits are unpredictable and difficult to calculate beforehand (Klijn et al, 2010). In this situation a certain level of trust is reassuring, and it contributes to the collaboration, it stimulates innovation by reducing uncertainties and providing a horizontal coordinating mechanism. Additionally, the network benefits from consensus building, network governance and fitting management (Sydow, Windeler, Schubert & Möllering, 2012).

Now that we have seen what innovation networks are, what forms they take and what their characteristics are, it is important to look at good collaboration in those networks. What is the effect of good collaboration in innovation networks?

Good collaboration in innovation networks is generally associated with a high level of innovation performance. Collaboration and cooperation result in gaining technical resources, new knowledge and know-how that broadens the capabilities of organisations and result in new innovative products. These results specifically address collaboration in a network composition; “*positive influence of networking behaviour on innovation output is confirmed by many studies*” (Morrar et al, 2012, p. 197). Sørensen & Torfing (2017) emphasize the importance of successful collaboration and see it as a superior driver of innovation. They mention that collaboration ensures that mutual and transformative learning is stimulated which has a positive impact on producing innovation and collaboration also generates support for new ideas and developments. They proverbial express innovation to be a team sport instead of the work of lone wolves. Collaboration encourages innovation by coupling and binding rather than by rejecting differences. Diversity between actors and ideas stimulates the creation of new inventions and inspires those involved.

Sørensen & Torfing (2017, p. 828-829) formulate four depending factors whether or not collaboration results in innovation. This depends on:

- [1] *the actors’ perception of the urgency of the problem or challenge at hand;*
- [2] *how much they trust each other and how well they communicate and deal with emerging conflicts;*
- [3] *whether past experiences, existing interdependencies, and the incentive structure allow them to reach some sort of rough consensus or shared agreement; and*
- [4] *the extent to which there are institutional procedures for sharing the costs and risks associated with innovation.*

When looking at successful or good collaboration, people tend to look at outcomes. In the private sector this is often a competitive antecedent, effectiveness, efficiency or financial win. For the public sector outcomes of innovation this is seen as more ambiguous. Besides a focus on collective effectiveness and efficiency (especially with a NPM approach), a focus on achieving and creating public goods and public value, acquiring trust, involvement of citizens and private partners, democratic legitimacy and enhancing democratic participation and deliberation (De Vries et al, 2015; Sørensen & Torfing, 2017; Hartley, 2005).

Summarizing the last two paragraphs, innovation networks are networks where patterns of interactions between heterogeneous actors result in desired outcomes of achieving innovation through mutual learning and an exchange of resources. Innovation networks are common in industries with a high degree of complexity, uncertainty and risks, where an increasing demand for network collaboration stems from high interdependencies and a high demand for expertise and knowledge. Three characteristics came forward, innovation networks are heterogeneous, dynamic and full of risks. Two compositions of how the collaborative process can take place have been cited: the model of Morrar (2015) and triple helix networks.

The network functions as arena where collaboration takes place. Good collaboration is largely associated with a high level of innovative performance. When the network is able to produce innovative outcomes, collaboration is positively experienced. Collaboration reinforces resource and knowledge exchange and inter-organizational learning, and vice versa: a high level of exchange and learning reinforces better collaboration. Good collaboration is stimulated by active participation and efficient interaction, which results in higher innovation output. What also contributes to the collaborative process is finding a joint vision, common ground and relation-, consensus- and trust building. Trust plays an important role in innovation networks since the risks are high and benefits are uncertain.

Network Management within Innovation Networks

In the section ‘network management within governance networks’ already a lot of network management and management strategies came forward. Theories and strategies mentioned there can also be applied to innovation networks. In this section, however, we discuss management that is more focused and applicable on innovation networks.

Network management within innovation and within innovation networks is, same as in governance networks, seen as important. Leadership activities, qualities and capabilities of managers seem to have great impact on achieving results. Lewis et al (2018) state that management has more impact than structures, processes, contextual factors and external networking. In addition, innovation typically involves uncertainty (for instance: ‘shall my investment result in innovation?’), exchange of valuable resources and collaboration between heterogeneous actors. The need for governance within these networks comes forth from this; strategic action is necessary to maintain the network and to continue the jointly innovative process. Li (2015) sees that “*success of (public) innovation is highly reliant on the degree to which it is competently governed*” (Li, 2019, p. 1). Furthermore, Koppenjan et al (2019) see free riding and opportunistic behaviour as threats within the innovation networks. To prevent actors from such behaviour and to ensure successful collaboration in innovation networks governance in terms of network management is needed (Ostrom, 1990). They mention three management strategies to overcome this and to enhance collaboration in innovation networks (Koppenjan et al, 2019, p. 5):

- [1] identifying and articulating common interests and objectives;*
- [2] establishing and enforcing formal and informal institutional rules; and*
- [3] by consensus and trust building, influencing preferences and strengthening a joint identity.*

The management of innovation networks can be designed different ways. Sørensen & Torfing (2017) see a challenge for network management, since in their perception, actors of innovation networks need to be influenced by the management to receive the benefits of the management, but also need a certain degree of autonomy. They find their solution in meta-governance, where autonomy is necessary for defining a purpose and objective, processes for achieving outputs and outcomes and the aims of the

network. If there is not enough autonomy involved actors will lose their interest and motivation in participating in the network, joint problem solving and then they are no longer open to find innovative solutions. A meta-governor aims to support, guide, and initiate collaboration. Tasks for managers are to provide resources, to facilitate interactions, to resolve conflicts and to develop frameworks (Li, 2019). Four governance strategies are identified by Sørensen & Torfing (2017, p. 829):

- [1] *political, discursive and financial framing;*
- [2] *institutional design;*
- [3] *network facilitation; and*
- [4] *network participation.*

Framing means that goals need to be established and common narratives and discourses need to be built, in order to facilitate interactions between the network members. Basic tasks, conditions and strategies are set here. With institutional design they refer to trying to change the institutional characteristics of the networks. Formal and informal institutions, rules that regulate behaviour, are created here, even as setting out basic rules for interaction and engagement (Lowndes & Roberts, 2013). Building trust and changing network members' perceptions are also included in this strategy. With network facilitation they mean the process management or facilitation by means of lowering transaction costs of interacting, supporting the mutual learning process, mediating conflicts and general support. It is the management of interactions with the intention of reaching collaborative innovation. The last strategy concerns the network participation. This equals direct participation, engaging with the network to directly affect the functions of the network. Which means influencing joint production of outcomes by aligning goals and defining decision-making criteria (Sørensen & Torfing, 2017; Li, 2019; Voest, Verhoest & Molenveld, 2015). You find similarities with the strategies mentioned in §2.1.3.

Network management can also be seen from another perspective than meta-governance. Dhanaraj & Parkhe (2006) see management as orchestrating activities. This network management involves subtle leadership, where a hub firm (a central actor in the network) takes a leading role in providing clear communication and trust building. In addition, hub firms can have significant influence on network membership and structure by brokering activities and recruitment (Orton & Weick, 1990). Within innovation networks value is effectively created and obtained by purposeful and deliberate actions, where knowledge is seen as the most essential source of the network and has to be shared among network members (Kogut, 2000). The hub firm has besides a leading, but subtle, role in the network three main management tasks, consisting of (Dhanaraj & Parkhe, 2006, p. 660-661):

- [1] *managing knowledge mobility;*
- [2] *managing innovation appropriability; and*
- [3] *managing network stability.*

The hub firm attempts to ensure knowledge mobility within the network. This activity consist of sharing knowledge between the members, provide acquired knowledge and to deploy it, this way value can be created, innovatory output will be maximized and advanced innovations might be achieved. The second management task is managing innovation appropriability. Appropriability is the degree to which a product, idea or service can be copied. A strong appropriability is whenever a product, idea or service is hard or impossible to copy (Kenniscosult, 2012). In innovation networks the focus of appropriability is on protecting the innovator and its intellectual property, often done by copyrights, trademarks and patents. It gives the innovator space to generate profits and unauthorized imitation is limited. If there is no clear agreement, problems of freeriding and opportunistic behaviour may occur. The created innovative value has to be divided in a fair way, and members have to identify it that way. This can be achieved by contracts and juristic ways, but social interactions, trust, interdependency, information sharing and joint problem solving seem more effective (Williamson, 1985; Macaulay, 1963). You could say that this concerns management of the institutional design, with a focus on processing innovation and knowledge appropriability. The third task Dhanaraj & Parkhe (2006) appoint is managing network stability. As is mentioned before, innovation networks can be characterized as loosely coupled systems. Loosely coupled networks may experience temporariness, barriers and stiffness (Weick, 1976). This does not benefit the innovativeness of the network and may lead to unpredictability. Instability may be

enhanced by competitiveness and lead to termination of cooperation and members switching to other networks. Instability may result in increasing complexity, lack of trust and uncertainty in the network. This has negative effects, such as actors refraining from making investments, decreasing synergistic advantages and an increase of possible opportunistic behaviour (Klijn & Koppenjan, 2016). The former implies that it is important for innovation networks to invest in network stability, especially since it has significant impact on investments and innovation. This can be done by enhancing reputation, lengthening the shadow of the future and building multiplexity.

And a third perspective on network management in innovation networks will be discussed. That is the perspective of Müller-Seitz & Sydow (2012). They see innovation networks as open innovation networks, based on the ideas of Chesbrough (2003) about open innovation. Open innovation consists of collaboration with partners from outside your own organisation, where interorganizational innovation is achieved by sharing knowledge in- and outside the boundaries of an organization (boundary spanning). Additionally, open innovation takes place on a cooperative manner at a network level to tackle technological complexities and incoherence. Ideas can be accessed external and development and risk costs can be reduced, which often leads to innovation and market opportunities (Sydow & Müller-Seitz, 2018; Chesbrough & Crowther, 2006). To achieve advantages, innovation networks need consensus building within the network, which must be driven by management. Coordinating (open) innovation networks requires specific collaborative (management) strategies and practices, which has been made more difficult since they conclude that not all networks have the ‘hub firm’ Dhanaraj & Pharke (2006) mention, but are more heterarchical and work on a horizontal way. This way there is no (or only quasi) hierarchical authority, so no manager is officially appointed and practices and structures of governance and governance management is needed (Sydow & Müller-Seitz, 2018).

Sydow & Müller-Seitz (2018) present four management practices on how to manage innovation networks, called ‘collaborative practices of partnering’. Practicing is perceived as “*ordered, recurring social activities that are relatively stable in time and space, and are shared by different actors. They are not single, isolated occurrences, but are rather part of an ongoing stream of activities in a particular context*” (Sydow & Müller-Seitz, 2018, p. 3). Their management tasks are as follows (Müller-Seitz & Sydow, 2012 in: Koppenjan et al, 2019, p. 7-9):

- [1] congregating organising;
- [2] inter-organisation projecting;
- [3] collaboration with fellow networks; and
- [4] technological road mapping.

The first practice consists of organizing (formal and informal) gatherings, agenda setting and roundtables. This can be seen as interaction and the network facilitation. Inter-organisation projecting involves providing research and design services (R&D), setting standards and creating joint projects. The third practice is about the collaboration with other networks, where joint objectives can be formulated, collaboration with government and linking up with international networks may take place (Sydow & Müller-Seitz, 2018). Here you can find a matching role for boundary spanners. And the fourth, and last, practice is technological road mapping. The aim of road mapping is to provide clarity in innovation processes and to support making strategic choices. Future objectives can be set here as a result of created consensus within the network (Sydow & Müller-Seitz, 2018; Koppenjan et al, 2019).

In this last paragraph about innovation networks we have seen different types of network management from three perspectives. Meta-governance, orchestrating activities and collaborative practices of partnering were discussed. These theories show differences and similarities, and in summary network management has to provide necessary resources (R&D services), provide clear communication and support, facilitate and guide the interaction process and bringing stability to the network. The following strategies have been most present in the management theory of innovation networks: identifying and expressing common goals and arriving at a shared-understanding (among other things by framing and narrative telling), establishing (formal and informal) institutions and standards, creating a fitting institutional design and to build consensus and trust between network members. The management has to facilitate the network by process and interaction management, lowering interaction costs, mediating

conflicts and supporting a mutual learning process. This can also be supplemented by organizing gatherings and roundtables and by agenda setting. Furthermore, by strengthening a joint identity, defining decision-making criteria and technological road mapping, joint production of innovative outcomes can be enhanced. And to further discuss the management of knowledge within the network, the management has to manage the mobility of the knowledge (thereby knowledge has to be shared between members, make sure it gets to the right person(s) and deploy it on the right way), furthermore, knowledge and intellectual property needs to be protected by means of management (by using copyrights, IPs and patents for instance).

2.3. Conceptual Framework and Merging Theory

The aim of the previous sections was to answer the first sub question of this thesis, namely: *‘What does the theory say about good collaboration and which factors are seen as important?’*. Much has been said about the characteristics and content of networks, collaboration, innovation and related emphasized factors. In order to translate this theory into more useful concepts for the empirical research itself, and to answer the research question: *‘Which factors influence the experience of good collaboration of a network situated in an innovative context, and which of these factors can be seen as most influential?’*. The theory of both governance and innovation networks shall be combined in this section into a conceptual framework.

2.3.1. Use and Adjustments of the Model

The several cited model of Ansell & Gash (2007) forms the basis of this framework. The four concepts of this model (starting conditions, institutional design, collaborative process and network management) are used, since the above described literature shows that these concepts can have a major influence on the degree of good collaboration. However, since we are looking at a network in an innovative context, the characteristics of innovation networks shall be applied to the four concepts. Together this forms the framework on which the research of this thesis is based.

The model of Ansell & Gash (2007) is, besides being supplemented with insights from the innovation literature, not entirely adopted; a number of adjustments are made. First of all, the relations that Ansell & Gash make within their model are not adopted. Where the model displays causal influences (starting conditions, network management and institutional design influence the collaborative process and the collaborative process influences outcomes), this research sees these variables as separate factors, where it is about the presence of these factors and which of these factors has the most impact on collaboration. Here the causal relationship between the independent variables and dependent variable are researched, and not the mutual causal relations between the independent variables. Secondly, where in the Ansell & Gash model 'outcomes' is seen as a result of the collaborative process, in this research the emphasis is not on the outcomes, since there are mostly intermediate outcomes and, according to those involved, the end product will take some time (years) to arrive. Therefore, outcomes will be treated globally, more to get a clearer picture of the network than it is perceived to be variable. This is supported by the assumption that a successful collaboration process is a precondition for achieving results and innovation. That is why we want to know how this good collaboration comes about and which factors contribute specifically to this.

This results in the following conceptual framework:

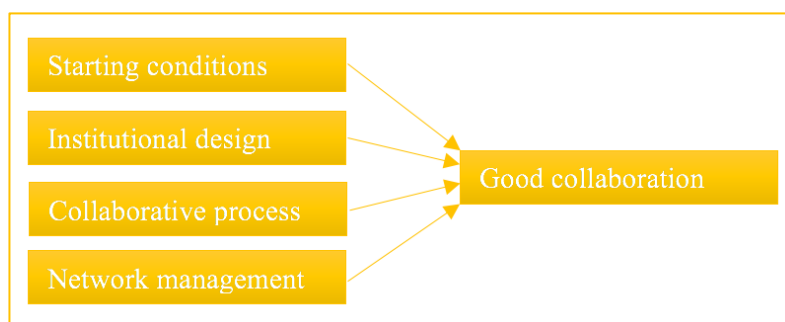


Figure 4. Conceptual framework.

The presence of the four concepts, which are constructed from governance and innovation theory (§2.1 and §2.2), and the influence of these concepts on good collaboration within the RAMLAB network will be examined in this research.

2.3.2. The Four Variables

In order to make the models properly researchable and measurable, the (independent) variables are divided into a number of sub-variables and corresponding assumptions will be presented.

Starting Conditions

Starting conditions create a basis before the collaboration starts. It generates certain expectations and therefore influences the collaborative process. If the starting conditions are considered, then based on governance literature (Ansell & Gash, 2007), three sub variables emerged: incentives and constraints on participation, asymmetries in power-resource-knowledge and the prehistory of cooperation are considered. This results in three sub variables of starting conditions that are analyzed in Chapter 5.

Looking closer at the assumptions associated with these sub-variables:

1. *Incentives and constraints on participation:*
When incentives outweigh constraints, it is more likely that actors join the network.
2. *Power-resource-knowledge asymmetries:*
When there is a big asymmetry in power-resource-knowledge balances, this can have a negative or manipulative effect on the course of the collaboration.
3. *Prehistory of cooperation and conflicts:*
When there is a prehistory of cooperation, and this is positively perceived, actors are more likely to collaborate again and it has a fostering function on cooperation. It also influences also the initial trust level; a successful history of collaboration leads to a higher initial trust level.

Institutional Design

When looking at the institutional design, the creation of a format that promotes collaboration is considered. Creating a well-fitting institutional design is seen as important in governance and innovation networks. Therefore, formal and informal institutions are studied, even as the basic rules for interaction, network structure, transparency of the process, inclusiveness of participation and exclusiveness of the forum. Especially in an innovative context it is important to have clear rules and a fitting design that protects innovation and intellectual property. This can be stimulated with agreements, contracts and IP rights, but also having a structure that matches the innovative context contributes to this. Referring to the designed structure of RAMLAB, looking at the way of organizing the network (heterarchical open innovation, self-organization or a hub organization that plays a central role) and if the network is conform to for instance the institutions of triple helix collaboration. It is examined whether, thanks to the design, the right resources are available, the organizations that are necessary to drive innovation (public, private, academy and end-users) are included. This results in five sub variables of the institutional design that are analyzed in Chapter 5.

Looking closer at the assumptions associated with these sub-variables:

1. *Rules within the network:*
When ground rules are clear this results in higher procedural legitimacy and trust building. It reassures network members that the process is fair, equitable and open. Therefore, having clear ground rules results in better collaboration. For collaboration concerning innovation, rules about intellectual property and protection of innovation are of big importance.
2. *Network structure:*
When the network structure is designed in a way that enhances the aim of the network, it is more likely that the collaborative process is more successful. When looking at the innovative context of the network, the triple helix design would enhance the proceedings of the network.
3. *Process transparency:*

When members are able to see the whole process and experience it as 'real' (not behind closed doors), the process is perceived as transparent. A transparent process adds to good collaboration.

4. *Participatory inclusiveness:*

The more inclusive the network is, the more stakeholders are able to participate. A broad inclusive network is seen as condition for successful collaboration (an open and inclusive design results in more commitment). Excluding stakeholders is seen as threat to the legitimacy and a factor of failure.

5. *Forum exclusiveness:*

The more exclusive the forum, the sooner actors participate in the network and do not seek alternatives.

Collaborative Process

When looking at the collaborative process in an innovative context, we look at the extent to which exchange of resources takes place, if inter-organizational learning occurs and if innovation stems from the collaboration. Creating innovation (innovation output) is seen as an indicator of a good collaborative process. Active participation and efficient interaction stimulate the collaborative process and, just as in governance networks, finding a joint-vision and common ground, consensus and trust-building contribute to the collaborative process. The complementarity of the relations provides an essential basis for good collaboration and a successful interaction process. This relation also works the other way around: good collaboration strengthens exchange of resources and interaction. Then, face-to-face interaction is seen as a factor that contributes to a successful collaborative process, therefore the interaction process will be studied. Interim innovation or intermediate outcomes seem to have a motivational and affirmative function on the collaboration, contributing to good collaboration. And at last the influence of interdependencies, trust and risks shall be considered, since they form a great motivation and incentive to ensure that the cooperation runs smoothly and is emphasized in both governance and innovation literature. This results in six sub variables of the collaborative design that are analyzed in Chapter 5.

Looking closer at the assumptions associated with these sub-variables:

1. *Resource and knowledge exchange:*

The more successful pooling of resource and knowledge takes place and inter-organizational learning occurs, the more this results in a successful collaborative process.

2. *Face to face dialogue and interaction process:*

The more successful dialogue takes place, the more this adds to a better collaborative process. When good faith negotiation forms the basis of dialogue, it contributes to a more successful collaborative process.

3. *Intermediate outcomes and innovation:*

The more intermediate outcomes are present, the more attractive this is to participate in the network. Seeing potential goals, small wins, providing strategic plans and conducting joint-fact finding contribute to this.

4. *Trust and trust-building:*

The more actors trust one another, and the more trust is built, the more this benefits the collaborative process. Trust reduces risks and costs, results in more predictability and stability and stimulates knowledge exchange and organizational learning. Interaction processes improve and problem-solving capacity is enhanced.

5. *Commitment to the process:*

The more committed actors are to the process, the more successful the collaborative process is. A high recognition of mutual interdependence (interdependency is a big promotor for collaboration in an innovative context), a high ownership to the process and a high openness to exploring mutual gains add to this.

6. *Shared understanding:*

A high level of shared understanding adds to a successful collaborative process. Formulating a clear mission, a common problem definition and identifying common values add to this.

Network Management

When the network is well managed, chances on tackling complexities and challenges are higher and the network performance, collaborative process and collaboration are more successful. When network management is considered: “*all deliberate strategies aimed at facilitating and guiding interactions and/or changing the features of the network with the intent to further the collaboration*” are studied (Klijn & Koppenjan, 2016, p. 11). Therefore, attention will be paid to strategies mentioned in governance networks and strategies mentioned by innovation networks. This is divided into two categories: general management strategies and management strategies focused on innovation. The most prominent management strategies, both appearing in the governance and innovation literature, are strategies such as facilitating and guiding the (interaction) process, trust- and consensus-building and providing an institutional design and arena for members to interact, so members can search for opportunities and mutual gains. Management strategies focused on knowledge and innovation concentrate on managing knowledge mobility (distribution), facilitating resource exchange and inter-organizational learning, innovation appropriability, technological road mapping and providing R&D services. It is emphasized that proper governance and management have a major impact on the success of collaboration in an innovative context. In addition to the strategies, attention is also paid to the role of the manager; is it a boundary spanner, administrative, adaptive or enabling leadership or something else? This results in three sub variables of the network management that are analyzed in Chapter 5.

Looking closer at the assumptions associated with these sub-variables:

1. *General management strategies:*
The better the network is managed, the better complexities can be tackled and network performance and success of collaboration rises.
2. *Management strategies focused on innovation and knowledge:*
The better the network management focusses on strategies that enhances innovation and knowledge progression, the more successful the collaboration in an innovative context works out.
3. *Network manager:*
The better the manager manages, the better effects on the collaborative process, outcomes and network performance. A well-fitting leadership style adds to performance and success.

CHAPTER 3: METHODOLOGY

The aim of this thesis is to answer the research question ‘Which factors influence the experience of good collaboration of a network situated in an innovative context, and which of these factors can be seen as most influential?’ and its corresponding sub-questions. To answer these questions, by the means of evaluative research, a combination of literature study (Chapter 2) and qualitative research is executed. How this is done exactly, shall be explained in the section operationalisation and research methods, beginning with the operationalisation of this research.

3.1. Operationalisation

For building a solid scientific foundation for this research it is important to have a clear operationalisation of the used concepts. Based on the former literature chapter and conceptual framework, the operationalisation of variables is constructed as following:

| Type of variable | Variable | Value |
|----------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Independent variable | Factors of collaboration | All factors interviewees mention to be important for the collaboration of the RAMLAB network. Factors from the framework have a steering effect in the research: starting conditions, institutional design, collaborative governance and network management. But there is also room for factors that are not mentioned in literature but emphasized by the respondents. |
| Dependent variable | Good collaboration | Perception of interviewees on most ideal form of collaboration in RAMLAB network. It is about the experienced good network collaboration. |
| Context variable | Context of RAMLAB | To create an overview of the network and to better understand the context they are situated in, a stakeholder- and network analysis are conducted. Here initial questions regarding the network are answered. It is analyzed what the network looks like, which actors are involved and what their contribution is to the network. In addition, an theoretical analysis of the network is conducted, where characteristics of governance- and innovation network are being researched. See section §3.2.3 for details of these analyses. |

| Sub-variable | Variable | |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | Value | Examination |
| | Starting conditions | |
| 1. Incentives and constraints on participation | The presence or absence of incentives and the presence or absence of constraints. And to what extent they are considered important for good collaboration by network members. | <ul style="list-style-type: none"> - Are there incentives present? - Are there constraints present? |
| 2. Power-resource-knowledge symmetries | The presence or absence of power-resource-knowledge symmetries. And to what extent this is considered important for good collaboration by network members. | <ul style="list-style-type: none"> - Are there power-resource-knowledge symmetries? - Do you think there is a balance in the input of resources/knowledge? - Do you think there are asymmetries of power-resource-knowledge inputs? - Do you think that these (power) relations have a manipulative effect? |
| 3. Prehistory of cooperation and conflict | The presence or absence of a prehistory between network members. And to what extent this is considered important for good collaboration by network members. | <ul style="list-style-type: none"> - Did you know any of the other participants beforehand? - Did you have a positive or negative experience? |

| | | |
|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | - Did this previous cooperation influence your decision on joining the network? How? |
| Institutional design | | |
| 1. Rules within the network | (a) The presence or absence of clear ground rules in the network. And to what extent this is considered important for good collaboration by network members. (b) The presence or absence of rules about knowledge and innovation in the network. And to what extent this is considered important for good collaboration by network members. | - Are there certain rules made within the network you know of? - Are there rules about the collaboration? - Are there informal (or unspoken) rules within the network? - Are there certain (interaction) patterns that people adhere to? - Are certain protocols drawn up? - Are there rules about IP-rights or innovation? |
| 2. Network structure | The presence or absence of a well-fitting structure that matches the innovative context. And to what extent this is considered important for good collaboration by network members. | - How is the network structured (heterarchical open innovation, self-organization or hub organization)? - Are the main organizations you need for innovation in this network (public, private, academia and end-users)? - Does it show the features of triple helix design? |
| 3. Process transparency | The presence or absence of the experience that the collaborative process is transparent. And to what extent this is considered important for good collaboration by network members. | - Do you think the network functions transparent? Why (not)? - Do you think you have insights in the decision-making process? Why (not)? |
| 4. Participatory inclusiveness | The presence or absence of an inclusive network design. And to what extent this is considered important for good collaboration by network members. | - Do you think everyone can participate in RAMLAB? Why (not)? - Do you think the collaboration process is open? Why (not)? - Do you think the network is inclusive? Why (not)? |
| 5. Forum exclusiveness | The presence or absence of an exclusive forum. And to what extent this is considered important for good collaboration by network members. | - Are there similar networks like RAMLAB? - Do you see them as an alternative of RAMLAB? |
| Collaborative process | | |
| 1. Resource and knowledge exchange | The presence or absence of resource and knowledge exchange between network members. And to what extent this is considered important for good collaboration by network members. | - Does exchange of resources, knowledge and inter-organizational learning take place? How? - Is synergy taking place between members? |
| 2. Face-to-face dialogue and the interaction process | The presence or absence of face to face dialogue and an interaction process. And to what extent this is considered important for good collaboration by network members. | - How does interaction take place? - How important is face-to-face dialogue to you and for the network? Why (not)? |
| 3. Intermediate outcomes and innovation | The presence or absence of intermediate outcomes and innovation. And to what extent this is considered important for good collaboration by network members. | - Do you experience that the RAMLAB network makes a lot of (intermediate) progresses? Why (not)? - Are potential goals and strategic plans clear to you? Why (not)? |

| | | |
|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | <ul style="list-style-type: none"> - Is there room for joint-fact finding? And, how? - Do you think having intermediate outcomes contribute to a better collaborative process? |
| 4. Trust and trust-building | The presence or absence of trust and trust-building between network members. And to what extent this is considered important for good collaboration by network members. | <ul style="list-style-type: none"> - Do you experience trust between members/within the network? - Are there certain tasks that are performed to increase trust within the network? - Do you see trust-building as an important factor for the functioning of the network? |
| 5. Commitment to the process | The presence or absence of commitment of network members to the process. And to what extent this is considered important for good collaboration by network members. | <ul style="list-style-type: none"> - Are you committed to the network? - Do you recognize mutual interdependency? Why (not)? - Is there an open attitude towards mutual gains? Why (not)? - Do you think there is a shared ownership of the process? Why (not)? |
| 6. Shared understanding | The presence or absence of a shared understanding between network members. And to what extent this is considered important for good collaboration by network members. | <ul style="list-style-type: none"> - Is a (clear) mission formulated in RAMLAB? - Is there a common problem definition jointly constructed? - Are values between actors shared? - Are there common values between actors? |
| Network management | | |
| 1. General management strategies | The presence or absence of management strategies that advance good collaboration. And to what extent this is considered important for good collaboration by network members | <ul style="list-style-type: none"> - Do you experience management strategies that advance good collaboration? - Do you experience management strategies that facilitate and guide the collaborative process? - Do you experience strategies that enhance trust between members? - Do you experience management strategies that enhance consensus? |
| 2. Management strategies focussed on innovation and knowledge | The presence or absence of management strategies that advance collaboration in an innovative context. And to what extent this is considered important for good collaboration by network members | <ul style="list-style-type: none"> - Do you experience certain management strategies concerning knowledge or innovation? - What type of knowledge management strategies do you experience (knowledge mobility, IP rights, R&D service, technological road mapping)? |
| 3. Network manager | The presence or absence of management strategies. And to what extent this is considered important for good collaboration by network members | <ul style="list-style-type: none"> - Can you appoint someone as a network manager? And who is this? - If not: How is the network managed then? How do people work together? - How do you think the manager performs as network manager? - What type of leadership style can be linked to the network manager (administrative, adaptive or enabling)? |

3.2. Research Methods

In this section the used research methods strategy shall be clarified. Starting with a short overview of the case study of this research, followed by the research purpose: evaluation research. Then the data collection methods are discussed, consisting of desk research and qualitative research, whereby conducting interviews is the chosen data collection technique. In addition, the manner in which measurements and analyzes are conducted is discussed, the research and its reliability, validity and objectivity are reflected on.

3.2.1. Case Study

For this thesis a network is thoroughly researched, focussing on the collaboration of this network and its related factors, with the aim to evaluate this. The case concerns the RAMLAB network, an innovative network, based in the RDM-yard located at the port of Rotterdam. In this paragraph a brief description shall be given of RAMLAB, but a more in-depth analysis of the network can be found in Chapter 4.

The specific network is RAMLAB, which stands for the ‘Rotterdam Additive Manufacturing Lab’. In RAMLAB research is conducted into the large-scale 3D-printing of metals, also called WAAM, for the port-related industry (RDM Rotterdam, 2017). RAMLAB is the name of the company who produces and develops the WAAM-technology, but the network related to this company is also called RAMLAB network. This thesis focusses specifically on the RAMLAB network. The network consists of actors related to the process, knowledge, specialism or end-users of WAAM and often related to the maritime industry. RAMLAB is founded in 2015 after a pilot project and the desire for more prototyping and further development of WAAM. The Port of Rotterdam is related to RAMLAB, it shares besides the role of (initial) financier, also the role as founding farther with Innovation Quarter and RDM Makerspace (RDM Rotterdam, 2017).

The RAMLAB network is chosen as a result of certain steps made along the process of writing this thesis. At first, the focus of this prior desk research was on networks focussing on the circular economy. Three projects were presented by the port concerning circular-economy: <https://www.portofrotterdam.com/en/doing-business/port-of-the-future/energy-transition/circular-economy>. In an orienting interview with Ms. Rijk from SmartPort Rotterdam, the RAMLAB network was recommended (personal communication, 05-03-2019). After contacting the project manager of RAMLAB, an orienting interview followed. In this interview a global introduction of the network, the functioning of it, the aims and mission were told. After that a network meeting was attended and the research officially began (personal communication, 11-03-2019; 29-03-2019).

3.2.2 Evaluative Research

The aim of this research is to answer the question ‘*Which factors influence the experience of good collaboration of a network situated in an innovative context, and which of these factors can be seen as most influential?*’. Therefore we look at the extent to which there is good collaboration taken place in RAMLAB, whereby the network collaboration is evaluated on. The aforementioned factors in §2.3 (which is equal to the operationalized variables of §3.1) form therefore indicators of good collaboration. From the theory of Chapter 2 follows that the presence of these factors indicate good collaboration in a network. To this end, this study will examine the presence of these factors and the extent to which they are considered important.

Evaluative research is often used to assess an organization’s operations, resources, quality and services. Often mentioned reasons for executing this kind of research are for instance accounting the use of resources, enhancing visibility, increasing efficiency, supporting activities and decision making, strengthen a position, highlighting goals or evaluating if the chosen path functions or not (Powell, 2006). In this case, evaluating if the current form of collaboration works (or not), and why (or why not). Evaluative research involves various aspects of research, such as process evaluation, impact or outcomes assessment, evaluating service quality and input, output or performance measurement. When the evaluation involves the measurement of numerical variables, often quantitative research methods are used (Powell, 2006). However, qualitative research methods are becoming increasingly popular when executing evaluative research. This because it “*tends to apply a more holistic and natural approach to the resolution of the problem than does quantitative research. It tends to give more attention to the*

subjective aspects of human experience and behavior” (Powell & Connaway, 2004, p. 59). Therefore, in this research there is chosen for qualitative research, more specifically conducting in-depth interviews. In the next paragraph the research methods for collecting data are discussed.

3.2.3. Data Collection

This research consists of two main methods for collecting data: desk research and qualitative research. The rationale for combining desk- and qualitative research is based on the type of research questions: theoretically and empirically questions. The first sub-question is a theoretical question and needs to be answered based on scientific literature, this is partly descriptive and partly explorative research. The descriptive research is utilized to research certain concepts and as a theoretical orientation. The explorative research is used for looking at the important factors concerning the dependent variable (network collaboration) and for retrieving in-depth insights. A combination of desk research and a case study are often conducted to answer these types of research, likewise in this one (Baarda, 2018; Fischer & Julsing, 2014). The empirical research builds further on the theoretical part. Based on the theory, it is examined which factors often occur, the empirical research tests these insights and looks which factors are or are not brought up by the respondents.

This research is largely deductive, since it is testing existing literature, and looks at its relevance, similarities and differences in this case. Based on existing literature and theory a conceptual model is conducted, which is the foundation of this research. The model of Ansell & Gash (2007), in combination with the other literature, is tested in the case of the RAMLAB network. General theory results in specific knowledge about RAMLAB. However, there is also small space for inductive research. There is the possibility of factors who are not mentioned in the literature are included in this research, because respondents mention them. For that reason also an inductive approach of observation (of the interview content) and finding certain patterns in this data is used and results are mentioned in the analysis. Furthermore, evaluative research is often seen as descriptive research, whereby attention is paid to certain aspects and a situation or phenomenon gets described. In this thesis specifically the factors of good collaboration. The following sections briefly discuss the specifics of the desk- and qualitative research of this thesis.

Desk Research

Desk research is often the starting point of research, and in this thesis as well. It is used for getting a better understanding of the subject, to answer the theoretical question and to outline a framework for the empirical research: the interviews. There are two types of desk research performed for this research: a literature study and a content analysis of mass communication sources (mainly the use of websites and technic blogs) (Fischer & Julsing, 2014). The literature study is mainly used to retrieve answers for the first research question: *‘What does the theory say about good collaboration and which factors are seen as important?’*. Searches were mainly focussed on governance, governance networks, innovation, innovation networks and collaboration, good or successful collaboration and the 17 factors. Also recommended literature of the master (Governance and Management of the Public Sector, Erasmus University Rotterdam) has been used, which provided a solid basis.

Qualitative Research

Qualitative research is a varied form of research, which can include any kind of data that is not numerous. In this research qualitative research is carried out in the form of doing interviews. Conducting interviews is a way of collecting information by conversations and interaction to answer pre-conceived questions. The purpose of doing interviews is finding out what the interviewees think of certain phenomenon and how they work (Emans, 2002; Eurib, 2010). This research began with two orienting interviews. Orienting interviews are used for retrieving necessary information in the beginning of the research (Trochim, 2006a; Boutain & Hitte, 2006). In these interviews a global introduction of the network, the functioning of the network and it aims and mission were provided (personal communication, 05-03-2019; 11-03-2019). Followed by attending a network meeting of RAMLAB, where presentations were held by RAMLAB employees, presenting progress of research and in-depth knowledge about the WAAM process. While attending, observations of the network and substantive

information about what the network is doing were retrieved and initial contacts with network members was made. Certain members already explained why they were joining the network, what they thought went well in the network and in this way people could be approached with the question of whether they want to participate in the interviews (personal communication, 29-03-2019). Attending this meeting emerged from an invitation from Mr. Wegener (the managing director of RAMLAB).

Subsequently, in-depth interviews were being held with the network members. In-depth interviewing can theoretically be divided into individual (one-to-one) and group interviews (focus groups). Opted for this research is the method of one-to-one interviewing. This way everyone can have the same degree of influence on the research and has the same possibilities of attention from the interviewer (Eurib, 2010; Trochim, 2006a). The interviews follow a semi-structured format. For this research it is considered to be necessary that certain subjects are being questioned (the factors), but there also has to be some leeway, so whenever an interesting subject comes up, it can be discussed in more detail. A topic list is used, so structure is provided. Main topics are based on the literature and conceptual framework of Chapter 2.

In the following table an overview of the executed qualitative research is given:

| Type of qualitative research | N |
|------------------------------|-----------|
| Orienting interviews | 2 |
| In-depth interviews | 10 |
| Attended meetings | 1 |
| Total | 13 |

Table 1. RAMLAB-network

The number of participants (N) depends on the positive response of the actors that have been asked to be part of this research. It began with Ms. Rijk, a contact from my thesis supervisor, which provided contact details of the managing director of the RAMLAB network. During the attended network meeting I was able to recruit the members face-to-face. As a result of this, only network members who were physically present this day were asked to participate, certain companies who are joining the network are therefore not asked to cooperate. However, the group of respondents is a diverse group of partners, members and end-users.

3.2.3. Measurement and Analyses

In this paragraph the method of measurement and analysis is explained. Starting with the unit and data of the analysis, followed by the analysis of the interviews, a stakeholder analysis and concluding with the network analysis.

Unit and Data of Analyses

The aim of an analysis of evaluative research is to convert data coherently. This requires to sort, arrange and process the acquired information. The aim is to represent the data and to transform this into meaningful information, whereby the research questions can be answered (Weiss, 1998). The analysis of the interviews results in in-depth knowledge of the networks, in addition, to create a holistic view of the network, a network- and stakeholder analysis are executed. The data will be used for answering both the Chapter 4 and Chapter 5, resulting in formulating answers of the research questions. The unit of analysis consist of the major entity that is being analysed. Since this research is at its core the evaluation how factors of collaboration influence the collaboration of the RAMLAB network as a whole but look at the perceptions of network members on collaboration, the focus of this study lays on the individual level. This makes the members the major entity of this study (Trochim, 2006).

Processing of In-depth Interviews

The interviews are recorded, transcribed and analysed. The transcripts are verbally transcribed, by using the tool 'Otranscribe' online. Ten out of twelve interviews were held in Dutch, two interviews and the

attended meeting were in English. Nine out of twelve interviews were face-to-face, two by phone and one by the application 'Zoom'.

After the transcribe process, the interviews were analysed. This is done in two ways: by making notes and by coding. The notes can be found in Appendix V, where the most striking remarks from the interview were noted, along with a list of factors that, according to the respondents, contribute to good collaboration. The coding process is carried out by the use of qualitative research program ATLAS.ti. Here, the transcripts were coded, categorised and classified. This program makes it possible to get a better understanding of the network, the insights and perceptions of the network members and what factors they think are most significant for collaboration. It is possible to make notes, generate quotations and create networks of analysis, which all contributes to a better, more structured way of analysing and thereby to better scientifically based research. This contributes to the validity, reliability and objectivity of the thesis. In Appendix II the codes of this research can be found.

Stakeholder Analysis

In this research a stakeholder analysis is carried out, which contributes to answering the second research question: 'What does the network of this case study look like?'. This is done with the purpose to retrieve in-depth knowledge about the network and its members. More specifically, this analysis is performed to obtain information about who the actors are, their roles in the network and what their resource input is. In this research, the stakeholders are network members. The network members show part of the content, what the network consist of and reflect the diversity and plurality of the network. A wide range of diverse actors ensures that various perspectives are shown and get the floor in a network. This can lead to enriched policy or processes (Jones & Flaming, 2003). In addition, academics argue that stakeholder analyses are increasingly important, because of the interconnectedness of the world and the role stakeholders play in achieving organisation's mandates, missions and visions (Bryson, 2004). This analysis is established from the guidelines of the World Health Organisation by Schmeer (1999):

1. Name and organisation of the actor
2. What is the position of the stakeholder?
What is the position of the stakeholder in the network and to what firm or organisation is the actor connected?
3. Is the actor an internal or external stakeholder?
In this research an internal stakeholder equals a network member, all non-member stakeholders are considered external.
4. What is the knowledge expertise and are the resources of the actor?
What is the specialisation of this actor? (because the specialized level of innovation networks). To what resources has the stakeholder access? What does the stakeholder bring to the network? By resources we consider all types of resources, such as human, knowledge, financial, technological, political, expertise and so on. Also registrate the quantity and (perceived) quality of it.
5. What are the interests of the stakeholder (network member) in this network?
What interests does the stakeholder have in joining, staying or leaving the network? Which advantages and disadvantages?

These questions are asked in the interviews. Since the interviews are semi-structured, some actors delve deeper into certain questions than others, which results in differences of extensity of answers, which must be taken into consideration.

Network Analysis

To get a better understanding of the network, its context and background, a network analysis is executed in Chapter 4. Here questions are asked about the course of the network over time, the developments of the network, its key events and the current network performance. This therefore mainly concerns the current collaboration, which means that it can be categorized under the collaborative process. However, it is not discussed in Chapter 5, because it deals with the facts of the network, and not with the perceptions or insights of the respondents. It is to clarify and deepen the context chapter, not to discover perceptions of good collaboration.

The following questions are asked in this network analysis, based on Klijn et al (2010) and Koppenjan et al (2019):

1. What does the network look like in terms of content?
2. What is the initiation of the network?
3. What is the network's development?
4. What are the key events of the network?
5. What does the network look like with a theoretical perspective?

In order to approach the network analysis theoretically, a theoretical analysis of the network is conducted. Here, the link is made between Chapter 2 and the network, and it is examined whether the network actually qualifies as a governance and / or innovation network.

The following questions are being asked:

Governance networks:

1. Can RAMLAB be examined as a network?
2. Can the activities that are taking place be considered as governance?
3. Can the network be considered as a governance network?

Innovation networks:

1. Is innovation taking place?
2. What type of innovation occurs?
3. Does RAMLAB meet the criteria of innovation networks by Li (2019, p. 4-5)?
4. Can the network be considered as an innovation network?
5. Can Morrar's (2015) private-public innovation networks model be recognized in RAMLAB?
6. Can RAMLAB be seen as a triple helix network?

3.2.4. Reflection

In this section we will look back and reflect on the research. The reliability, validity and objectivity of this research are discussed, as well as the limitations of this thesis and a reflection on the interviews.

Reliability, Validity and Objectivity

In order to assign value to this thesis, the research must be verified in terms of quality. Often people look at the reliability and validity of a research, which plays particularly an important role in quantitative research. However, when doing qualitative research it is more difficult to use those concepts, since the quantifiability is largely missing, and therefore these concepts must be applied in a way that is consistent with qualitative research. In addition, it is therefore recommended to also look at the objectivity of the research, which complements the reliability and validity of this research (Halfman, 2019).

To begin with the reliability of this thesis. To label a research as reliable, it must be possible to reconduct the study and then present the same results. The results must be independent of chance and must be based on scientifically based methods that are repeatable (Fischer & Julsing, 2014). To ensure the reliability of this research, the above methodology is extensively described, which makes the research reproducible. The choice was therefore made for transcribing, coding and taking notes. The details of these processes can all be found in the appendix, which contributes to the transparency of the research and the reliability. However, it should be noted that the research object is a network, consisting of people, their interactions, perceptions and preferences, which are changeable over time. In addition, members describe the network as a vital, dynamic network, where members join and leave the network over time as well. Finding the exact same answers is for that reason more difficult, but this is logical and the methods used allow a comparable research. However, more choices were made to increase the reliability of the research. A quiet location was chosen, so that people became less distracted or disturbed. The attitude of the interviewer was as open as possible during the interview, with a focus on opposing guiding questions and socially desirable answers. Additionally, Geert (1973) states that for the reliability of qualitative research men should look at a thorough context description, also called a 'thick description'. Through this description, meaning can be given to observations and analysis, that might not have been found without context and, in addition, various contexts can provide different meanings

of situations. It is important to take this into account, which is mainly done in Chapters 4. Here, first and foremost, the context is created as a whole, where thanks to stakeholder- and network analysis the context is sufficiently described. This also affects Chapter 6, where answers to the research questions are formulated, even as the conclusion of the research. It is also argued that thick description not only contributes to the reliability of the research, but also to the external validity (University of Amsterdam, n.d.).

Validity refers to the presence or absence of systematic bias. Internal validity is about the credibility of the research; looking at the extent to which research methods ensure that the results and conclusions are actually related to the intended research concepts (Van Zwieten & Willems, 2004). ‘Did you really research what you claim to have researched?’ and ‘Have you measured what you wanted to measure?’ are questions that I have asked myself here. To increase credibility (internal validity) collected data should be properly documented (Halfman, 2019). This is, as said before, done by transcribing, making notes, coding and to display this in the appendix. Also the whole written document of all interviews is available for readers. Then attention must be paid to systematically applying methods, and not proceed this selectively. In this research, this was considered during the analysis, and with this awareness attempted to reduce the chances of this. External validity is about to what extent the results can be generalized, also called the transferability of the research. ‘Are the findings of the study also valid outside the context of the study?’. Here thick description may play a role again, by accurately describing the circumstances, the research becomes easier to replicate and the results can better be interpreted. To increase external validity, there was looked at the choice of respondents. The respondent should be representatives of the network, so that their joint statements can be generalized for this specific network. However, this research is a case-study, whereby the emphasis is on the content and less on the generalizability of the research.

And at last: the objectivity of this research. It is difficult to achieve full objectivity in qualitative research, since you want to know something subjective, the experiences or perspectives of the respondent, which is also the case in this study. While analyzing data you are also influenced by your own experiences and history, which again results in more subjectivity. Nevertheless, as much objectivity as possible should be sought. This can be done by the means of presenting inter-subjectivity and in the interest of presenting other perspectives. This means that all respondents must identify with the research, also those with a different opinion must be addressed. In this study, this has been done as much as possible by making sure that everyone is treated as evenly as possible during the analyzes, that the codes are systematically used and that the statements that deviate are (also) highlighted. During the analysis, constant account was taken on increasing objectivity, and letting own influence and steering happen as little as possible. This way, as much as possible has been attempted to remain objective and to allow everyone's perspectives to be addressed.

Limitations of Research

Some limitations occur in this thesis. Firstly, the choice of respondents has been considered. Explicitly, at least one person of each position has been chosen, accordingly both the core of the network, the partners and the members are represented. Also the end-users, producers and the knowledge providers are represented. But the respondents were selected on the basis of the attendance of a meeting of RAMLAB, so non-attending members were excluded. This can have had a guiding effect, because it means that (it is possible that) they are people who already are more motivated and more involved in the network than others. There may be a selective limitation here. However, this can be nuanced because the interviews show that the people who have the most impact are also most present at the meetings and also have the largest share in the collaboration. In that respect, it is an advantage that is selected within this group. Furthermore, two respondents from the same company were both asked, the group of respondents could have been more varied. However, this research is about their individual perception on good collaboration and related factors, so in that respect that fact is less relevant to the results.

Another limitation of this research was the lack of making adequate choices while doing the desk research. Too many variables were selected and too much literature was presented, this had to be shortened at the end of the investigation. This has delayed the research process and provided difficulties in defining the dependent variable and I had to retroactively make choices about the research design, methods and analysis.

Furthermore, there are some disadvantages to qualitative research. Powell (2006, p. 111) mentions some limitations, namely: the limited ability to provide objective data, it is often labor intensive, to provide precise reports of outcomes and to produce generalizable results. In addition to this, this research consists of only one case study. The study would have more impact if it had been a comparative study, where several case studies could be compared with each other. Then more generalizing statements could be made. Unfortunately this was not possible due to a limited time span.

CHAPTER 4: EMPIRICAL CONTEXT

In this chapter the empirical context of the case study shall be sketched, which means that the RAMLAB network is extensively studied. The purpose of this chapter is to answer the second research question: ‘*What does the network of this case study look like?*’. A combination of online research and of information retrieved from the interviews form the basis of the information provision. This chapter starts with an introduction of RAMLAB (the company), followed by an explanation of the RAMLAB network. This thesis focuses on the network, but it is important to understand what the company stands for, so it is easier to understand what the RAMLAB network is.

4.1. Network analysis

In order to describe the empirical context of the network in a structured manner, the questions that have been drawn up in the method chapter will be completed. This means that the following questions will be addressed:

1. What does the network look like in terms of content?
2. What is the initiation of the network?
3. What is the network’s development?
4. What are the key events of the network?
5. What does the network look like with a theoretical perspective?

When looking into RAMLAB, first a distinction must be made between RAMLAB the company and the associated network. The activities of RAMLAB and their proceedings will be discussed, followed by an introduction of the RAMLAB network, its members, initiation, developments, key events and the network are analyzed on the basis of literature from Chapter 2. The stakeholder analysis will be processed when getting to know the network and its members.

4.1.1. RAMLAB: The Company

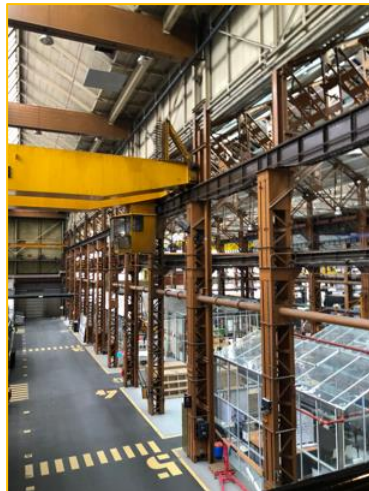
“Industrial spare parts should always be available wherever they’re needed, whenever they’re needed. Next to that, they should also meet or exceed the end user’s quality requirements at a competitive price. Additive Manufacturing, specifically Wire Arc Additive Manufacturing (WAAM), has the potential to enable the wide-scale availability of on-demand certified metal parts. RAMLAB’s mission is to accelerate the adoption of WAAM technology by providing its partners with easy access to the entire value chain”.

(RAMLAB, 2019c, p. 1).

RAMLAB is short for ‘Rotterdam Additive Manufacturing lab’. RAMLAB is a field laboratory, specialized in 3D-metal printing focusing on the maritime sector. RAMLAB consists of researchers, material scientists and robotic- and software engineers. It is a start-up that is established by three so-called founding fathers: RDM Makerspace, the Port of Rotterdam and Innovation Quarter (RAMLAB, 2019d). RAMLAB researches and develops theoretical and practical knowledge in the era of 3D-metal printing, 3D-welding design and certification. The aim of RAMLAB is to make the Wire Arc Additive Manufacturing (WAAM) technology commercially usable and RAMLAB is working on a future in which parts can be printed on demand (Port of Rotterdam, n.d.c). Their vision is providing technology to print ‘*large scale metal parts on demand*’ by WAAM technology, so the industry is less dependent on stock (RAMLAB, 2019b, p. 1).

RAMLAB is located at the innovation dock of the RDM-campus (Research, Design and Manufacturing-campus), directly situated and connected to the port of Rotterdam and the industry they are working for. In addition, the *Hogeschool Rotterdam* (Rotterdam University of Applied Sciences), the *Techniek College* (School of Engineering), starting entrepreneurs, research and design institutes, the business sector and hobbyist are located in this open-space dock. Therefore, the exchange of best practices, sharing knowledge and networking is promoted in this area (RDM Rotterdam, n.d.; Van der Beek, 2015). The innovation dock is seen as an inviting and inspiring location, by its visitors and by RAMLAB’s members, apparent from the conducted interviews. The workspace of RAMLAB consists of offices, meeting rooms, test and development spaces. These spaces facilitate the development of

WAAM hardware and software, the pooling of resources, knowledge and experiences, it offers space for meetings and gatherings and for performing 3D printing with laser robots. The innovation dock is visible on the left photo, the research and development (R&D) space of RAMLAB on the right photo. In the innovation dock you see the connectedness with the maritime sector and the industry. In the R&D space, you can find the robots are behind the red curtains, they are closed because of the light radiation of the lasers. Furthermore, green bottles of gas are visible on the right picture, one of the materials that are being used while 3D-printing, just as different types of steel wires, that differ in density and sort, based on what is required in the prototype, model or section.



Picture 1. Innovation Dock at the RDM-yard, port of Rotterdam.



Picture 2. R&D space of RAMLAB in the Innovation Dock.

Wire Arc Additive Manufacturing (WAAM)

Additive Manufacturing (AM) is also known as 3D-printing. It is seen as a promising technology, which according to predictions, will have a major impact in future industries such as the medical and maritime field. Frazer (2014) says it has “*the potential to revolutionize the global parts manufacturing and logistics landscape*” (Frazier, 2014, p. 1917). The big advantage of AM or 3D-printing is that it provides the possibility to produce products or components that are customized in measurements that were impossible or extremely difficult to produce, in perspective of standard manufacturing. This technology offers possibilities that were unthinkable before (TNO, n.d.). Academics state for instance that it can transform the logistics landscape, by the possibility of printing parts on-demand and distribution of the manufacturing process. There are both ecological and economic benefits for using this process, since it reduces CO₂ emissions, energy consumption and manufacturing costs (Frazier, 2014).

RAMLAB does not necessarily focus on the AM-process, but their focus lays on the WAAM process. WAAM stands for Wire Arc Additive Manufacturing. The WAAM process is not only a process of 3D-printing, but it is a welding process that uses 3D-printing models and welding robots to create products. RAMLAB’s specialization focusses on ‘*developing the WAAM expertise*’ and the on-demand production of certified metal parts (personal communication, 01-11-2019). The certification of those products is something that distinguish them from other companies that are also working with WAAM, since they were the first in the field to print a propeller that was officially certificated (personal communication, 11-03-2019; 06-05-2019; 20-09-2019). Benefits RAMLAB mentions of WAAM are the decrease of material costs and lead times, so the production of parts is much quicker than traditional welding and high quality of their products (RAMLAB, 2019a). This was discussed in the interviews, respondents tell that, thanks to WAAM technology, whenever a part of a ship breaks in the near future, they no longer have to wait for 3 months in a port on a part that needs to be shipped all over the world. Using the WAAM technology, this part can be printed in the nearest port, and can be reassembled within a few weeks (instead of months). In addition to manufacturing new products, RAMLAB also offers 3D-scanning repair solutions with robotic welding (RAMLAB, 2019b).

“With the 3D printing method, metal is welded layer by layer with a robot. Thanks to the unique arrangement, at RAMLAB we can print objects of two by two meters over a length of six meters. However, that is necessary in this sector. Where a traditional manufacturing process of a specific ship part takes six to eight months, it can be arranged with us in a few weeks.”

(Wegener, 2017, p. 1).

Now that we know what WAAM entails and what RAMLAB is specialized in, it is interesting to see where RAMLAB comes from and to look at their initial phase.

3D-Printing: Applicability in the Maritime Sector

Initial ideas of the founding of RAMLAB are based on a research of 3D-printing in 2014, carried by Hoogvelt & Buining (2014). This research was supported by a working group consisting of eight partners (3D-Project B.V., Damen Gorinchem, IMTECH, Kenniscentrum RDM Mainport Innovation, RDM Makerspace, Siemens Industry Software, TNO and Netherlands Maritime Technology). The aim of this research was to investigate 3D-printing and related possibilities and advantages of application in the maritime industry. The main findings are that 3D-printing has possible benefits for the industry and that there is a need for further research from affiliated companies and the industry. The research recommended a number of activities, such as feasibility studies, pilots, knowledge transfers, the sharing of R&D facilities, and advised to collaborate and share knowledge and experience between relevant actors (Hoogvelt & Buining, 2014). You can find this research on: <http://docplayer.nl/984588-3d-printing-toepasbaarheid-in-de-maritieme-sector.html>.

In that research RDM Makerspace was represented by Mr. Wegener, who continued exploring possibilities of this project. People were contacted, business cases considered and congresses and companies visited. Wegener played a big role in the initiation of RAMLAB. His starting point was to make people enthusiastic and to look at the feasibility of WAAM ideas. This resulted in the establishment of RAMLAB in 2016 (RAMLAB, 2019d; personal communication, 23-09-2019). RAMLAB is a company that looks ahead, wants to be innovative and wants to develop knowledge and products in the field of WAAM. But the knowledge and processes are complex and the required resources for this start-up are not completely within the reach of the RAMLAB (personal communication, 01-11-2019). Therefore, they need help from others, from knowledge institutes and specialists at every step of the process; in the field of steel, data, robots, and high-quality knowledge specialists. In other words: they need a network where knowledge and experiences can be shared.

4.1.2. RAMLAB: The Network

It is clear that especially in the initial phase RAMLAB really depended on other actors for, so to say, get their business going. But not only in their initial phase, also nowadays they emphasize their need for insights, specialisms and experiences of their network members.

The Members of RAMLAB

RAMLAB was from the beginning dependent on other actors related to the maritime sector and the WAAM process. The founding fathers of RAMLAB and the initial financier of this start-up, the Port of Rotterdam, already had their own network and contacts, which RAMLAB could use as a starting point and build on. Also other companies, such as the Materials Innovation Institute (M2i), helped and helps by building the RAMLAB network. This by connecting universities and linking other related companies to this network, looking at who they thought would fit in and would be interested.

“If you want to do this well, you need to collaborate with the academical field. They must develop the right knowledge.”

(Personal communication, 23-09-2019).

In the quote above it is recommended that the academical field should be involved in the process. This has laid the foundation for a triple helix collaboration; the interactions and synergy between the public sector, industry and academia. This also corresponds with the characteristics of the innovation networks

framework of Morrar (2015), where both public and private actors interact, so as to arrive at jointly output innovation.

In Figure 5 you can find an overview of the 26 partners of the RAMLAB network. The RAMLAB network can be divided in four groups: the initiators of the network (3 organizations), partners or RAMLAB (5), academic partners (2) and the members (16). It consists of public and private organisations, although it is largely private organizations that are part of this network. In Appendix III an extensive overview of the network members is presented, with more details per organisation, their specialization and sector. The network comprises a mix of organizations that provide hardware, software and guidance on the certification of the WAAM process and several end-users of WAAM (RAMLAB, 2019). For instance, organizations that are involved are gas, oil and pipe specialists, software and analytics developers and academia. Even though their specialisms differ, a notable similarity between the organisations is their strive for innovation and progression. It should be noted that there is no legal obligation to enter or to remain in the network, making inflow and outflow dynamic and changeable. The overview is the current composition but may therefore change in the short term.



Figure 5. RAMLAB's network (RAMLAB, 2019).

Stakeholder Analysis

To obtain information about who the actors are, their roles in the network and what their resource input is, a stakeholder analysis per respondent is executed. In Appendix IV you can find the ten analyses.

Three people were interviewed from RAMLAB company, of which the co-founder/managing director, a software- and mechanical engineer and a WAAM engineer. This means that both insights are obtained in the higher-level operations, materials and the technological process. In addition, the aim was to achieve the widest possible range of interviews. For example, respondents from the academic sector, the private sector, specialists from various disciplines (for instance software and robotics specialists) and end-users have been interviewed. This includes people who are involved with RAMLAB on a daily basis, as well as those who occasionally submit projects and organizations that are more on the sidelines and only want to stay informed and receive updates of WAAM. The functions the respondents hold are primarily sales- or program manager, consultant or engineer. When speaking in terms of internal and external stakeholder, as the World Health Organization (Schmeer, 1999) has classified, all respondents are considered internal stakeholders. This is based on the website of RAMLAB (www.ramlab.com) where they consider the members as their network, and the interviews confirmed this. The stakeholder analysis shows that respondents are specialized in robotics and welding technology, aviation engineering (WAAM), on- and offline programming of welding equipment and robots, specialization in materials and production of additives, automating software process, networking and bridging the gap between academia and industry. In addition, the members contribute not only with their own specialism, but also with their experiences and submitting case studies. Respondents mention different interests they have in RAMLAB. During the attended meeting they mentioned for example that they did not want to miss the boat, so to speak. They (and their associated companies) see something in WAAM and do not want to board on this technology too late, but wanting more to be like pioneers and stay up-to-date from

the beginning. An interest that is often mentioned in the interviews is that they, as an organization, want to support the further development of 3D-printing and thereby want to keep an eye on the technology and make WAAM bigger (greater reach and impact):

“RAMLAB is one of the first to use 3D-printing with metal and welding. This is a (relatively) new technique, in which we saw potential from the beginning. We want to ride along with this technology and innovation.”

(Personal communication, 20-09-2019).

People are aware of the complexities associated with these developments and the related interdependencies on each other's specialism, in which the desirable outcome of joining is, among others, symbiosis and synergy. Therefore they enhance the exchange of knowledge, resources and experiences with the other network members, whereby RAMLAB is an arena that facilitates this. Further interests in RAMLAB are the presence of professionals with high levels of knowledge, their comprehensive approach (both in-depth research into the process and materials), possibility to do feasibility studies and to see if certain products meet the wishes of possible (future) customers.

Key events of RAMLAB

In the foregoing parts of RAMLAB's development has already emerged. This will be further discussed with more recent events. Starting with the following timeline:

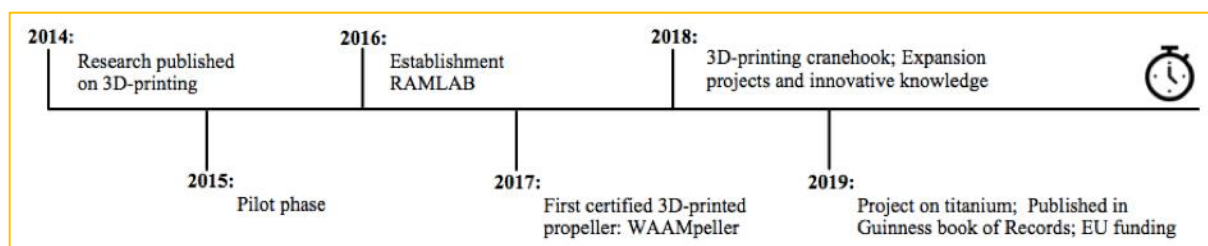


Figure 6. Timeline of RAMLAB

As we know, ideas of RAMLAB initiated after the research of Hoogvelt & Buining (2014), which was followed up with a pilot phase. When this pilot phase outlined positive results for further possibilities, RAMLAB officially established in November at the RDM-yard in the port of Rotterdam. Within a year, in September 2017 they booked their first result: world's first certified 3D-printed ship's propeller was manufactured and passed all quality inspections and is thereby certified (Port of Rotterdam, 2017). The next big event followed in 2018, when a 36.000 kg 3D-printed (and certified) crane hook was installed on an offshore vessel:

“Tipped to be the first 3D printed crane hook in history, the installation marks an important step forward in the production, and acceptance, of end use 3D printed heavy lifting components in the maritime and offshore industry.”

(Colyer, 2019, p.1)

In the beginning of 2019, RAMLAB was mentioned in the Guinness Book of Records, with their first 3D-printed ship propeller (WAAMPeller). Their next event, while developments and research into WAAM technology continues, was receiving funding for printing with titanium, followed by another funding at the end of 2019, this time a funding of ten million by the European Union (RAMLAB, 2019). The development of knowledge towards 3D-printing continues as a joint project, and by the opinion of the respondents, probably will be for quite some time. A further focus they have is on sorting out and improving the certification process and executing several feasibility studies and cases, so that even more knowledge can be gained and the network learns by try-and-error until their next key event.

Theoretical Analysis of the Network

Originating from Chapter 2 a theoretical analysis is composed as part of the network analysis. This is based on the paragraphs on characteristics of governance and innovation literature. Short, concise answers will be formulated, as a result of which the network has also been theoretically investigated. Beginning with governance networks, the following questions are formulated:

Governance networks:

1. Can RAMLAB be examined as a network?
2. Can the activities that are taking place be considered as governance?
3. Can the network be considered as a governance network?

Starting with the first question:

1. Can RAMLAB be examined as a network?

A network is characterized by: *“three or more legally autonomous organizations that work together to achieve not only their own goals but also a collective goal”* (Provan & Kenis, 2007, p. 231).

RAMLAB can be examined as a network; at this moment RAMLAB consists of 26 autonomous organisations that strive to advance WAAM technology. This is more than three legally autonomous organizations that work together, and they try to achieve their collective goal (matured 3D-printing technology).

[1: ✓]

2. Can the activities that are taking place be considered as governance?

Governance is characterized as: *“the use of institutions and structures of authority and collaboration to allocate resources and to coordinate and control joint action across the network as a whole”* (Provan & Kenis, 2007, p. 231).

The RAMLAB network activities revolve around resource allocation and joint action (for instance the joint fact finding of WAAM, making WAAM a success together, by sharing resources to advance the technology). Institutions and structures (mainly through the institutional design and network management) steer and coordinate this. Used institutions are for example having a collaborative spirit, wanting to help each other as much as possible and having clear, open and honest communication and reacting at a good pace. The governance is carried out by the management, RAMLAB company, who leads the network like a spider in the web on the basis of rules, facilitation of interaction and the provision of R&D services. Therefore it can be argued that governance is taking place in RAMLAB.

[2: ✓]

3. Can the network be considered as a governance network?

A governance network is characterized as: a network of interdependent actors, who exchange resources and try to influence, steer and use strategies, which cluster around problems, programmes or sets of resources, who emerge, are sustained and changed through interaction.

When asking if RAMLAB can be considered a governance network, the answer is yes. On one hand, simply by superficially stating that it is a network and, as we have just concluded, and governance is taking place; it can therefore be seen as a governance network. However, in order to do this in a substantiated way, it is first tested whether it meets the above formulated definition of governance networks. Looking at the first characteristic: ‘a network of interdependent actors’. As is stated in the foregoing, and which will be further substantiated in section §5.1.3., there is a high degree of mutual dependency. The network participants all have their own specialism, their piece of the puzzle, but cannot complete the puzzle by themselves, therefore collaboration and the pooling of resources is necessary. Then, the second characteristic ‘who exchange resources’. It follows from the interviews that the core of the network consists for a big part of the pooling of resources, and thereby the exchange of knowledge, experiences and hardware. The third characteristic: ‘who try to influence, steer and use strategies’; the members all have their own specialism, experiences and expertise on specific parts of the WAAM process. The combination of this constitutes a valuable input on the path of course that RAMLAB takes,

therefore exerting influence and steering the process. Then, the fourth characteristic is ‘which cluster around problems, programs or sets of resources’. RAMLAB clusters around problems (or challenges) with WAAM-development, because of its uncertain, interdependent and innovative context. Then the fifth, and last, characteristic that follows from this definition is ‘who emerge, are sustained and changed through interaction’. The respondents emphasize the importance of communication and interaction within the network and between the members. Especially their interaction process with RAMLAB company is seen as important, since they value that relation in the network the most. In the meetings interaction takes also place with the other members, or by projects with RAMLAB company and other members, where new ideas and room for symbioses of knowledge arises, which impacts the process. From the foregoing you can conclude that all five conditions have been met and RAMLAB can be seen as a governance network.

[3: ✓]

All three questions are answered positively, RAMLAB is a network, where governance takes place and can be characterized as a governance network. Next, it will be examined if RAMLAB can also be characterized as an innovation network:

Innovation networks:

1. Is innovation taking place?
2. What type of innovation occurs?
3. Does RAMLAB meet the criteria of innovation networks by Li (2019, p. 4-5)?
4. Can the network be considered as an innovation network?
5. Can Morrar's (2015) private-public innovation networks model be recognized in RAMLAB?
6. Can RAMLAB be seen as a triple helix network?

Starting with the first question:

1. Is innovation taking place?

Innovation is seen as: *“the creation of new, technologically feasible, commercially realizable products, processes and organizational structures, emerges from the ongoing interaction processes of innovative organizations”* (Ahrweiler & Keane, 2013, p. 76).

It appears from the interviews as well as the online documents that RAMLAB produces innovation. This is evident from the statements made that RAMLAB is the only or first to engage in WAAM in the maritime sector, as well as from articles that state that they are the makers of world's first 3D-printed ship's propeller, and thereby reach the Guinness Book of Records. The production of the two propellers can be seen as innovation, but their progress in the development of WAAM technology can also be seen as innovation. The interviews show that this innovation is driven by pooling of resources, exchanging knowledge and experiences and through in-depth study and on-site try outs.

[1: ✓]

2. What type of innovation occurs?

Considered types of innovation: product-, process-, position-, strategic-, governance- and/or rhetorical innovation (Hartley, 2005; Walker, 2014; Damanpour & Schneider, 2009).

Looking back at the literature from Chapter 2, it appears that both product- and process innovation occur. Product innovation means that a new product is being produced. The objects produced on the basis of WAAM differ in material composition and design, creating a new type of product. Furthermore, process innovation means a new design of the organizational processes, methods and techniques. This form of innovation is also occurring. The methods that RAMLAB uses, the WAAM technique, is seen as a new method to use welding in a new (innovative) way. The other innovation forms do not apply.

[2: ✓]

3. Does RAMLAB meet the criteria of innovation networks by Li (2019, p. 4-5)?

- [1] Innovation networks are not homogeneous, but heterogeneous;
- [2] an innovation network is dynamic; and
- [3] an innovation network is full of risks.

In the foregoing the network members of RAMLAB are described. This is a diverse group, in which both public and private institutions are involved, as well as academic parties, standard setting bodies and industrial associations. When looking at a dynamic network or process, this is characterized by constant activity, progress or change. Respondents described the network as dynamic, thanks to an in- and outflow of members, with the possibility of uncoupling ties and a fragmentation of the processes from time to time. At the core of the network you can find stability, but others are free to go wherever they want, and if you can do little work for the network of the network for you, you are not stopped from leaving the network; which also has happened. In addition, the interviews show that constant work is being done to make progress in the process, to make progress with it. And at last, risks. In innovation networks risks can manifest itself in various ways, such as financial-, technological- and market risks, but also turbulent events can result in uncertainty and are considered a risk. Respondents say it is not certain that 3D-printing will be used in the future; that there will be a demand and a market for it. It is therefore possible that the investments they do (time, money, manpower, etc.) will not pay themselves back. This implies that the members (and RAMLAB company) take on a (major) risk.

[3: ✓]

4. Can the network be considered as an innovation network?

Innovation networks can be considered as: “*patterns of interaction processes between a set of heterogeneous actors producing innovations at any possible aggregation level*’ by the realization of *inter-firm learning, complementarities and synergies*” (Kuppers and Pyka, 2002 in: Koppenjan et al, 2019, p. 3).

There are courses of communication and interaction taking place between the actors, they communicate by mail, telephone and face-to-face. From the foregoing question we know that the members are a group of heterogeneous actors. What has been discussed already is the innovation they have produced so far. The end product is not yet finished (a fully on-demand operating WAAM system), but innovative intermediate outcomes have been produced, such as the propellers and the progress made in the technology, processes and materials. In addition, the interviews also endorse that inter-firm learning takes place, the companies complement each other, and that joining their forces results in better results, greater than the sum of their own, separate work. More attention will be paid to this in Chapter 5 (§5.1.3). Therefore the conditions are met and RAMLAB can be called an innovation network.

[4: ✓]

5. Can Morrar's (2015) private-public innovation networks model be recognized in RAMLAB?

Do public and private actors interact? Does resource exchange take place while interacting? Does this interaction lead to innovation output (product innovation or process innovation)?

There are interaction patterns between public and private actors. However, as was said before, private organizations (mainly industrial associations) are present in larger numbers than public actors. The public institutions of this network (Port of Rotterdam, Innovation Quarter) have been of great importance in the beginning of RAMLAB, but step partly into the background when concerning daily activities. Resource exchange can be seen as one of the core activities of the network, especially the exchange of knowledge and experiences are seen as important, in addition to inter-organizational learning. And the interviews show that these exchanges result in progress of the technology and achieving product innovation (such as the WAAMPeller).

[5: ✓]

6. Can RAMLAB be seen as a triple helix network?

Is collaboration taking place between the industry, government and the academical field? Is knowledge seen as an important of the network?

What has been made clear in the foregoing, and what can be clearly seen in the overview of Appendix III, is that public, private and academic actors are connected to this network. Reasons for this are endorsed in the interviews, making the connection with fundamental research done by knowledge institutes and universities. In this way that the complex processes can be well substantiated and scientifically supported, which leads to a higher quality and therefore more confidence in RAMLAB and the network. Also when looking at the traditional structure of the triple helix network, then the designated functions per sector can be observed in RAMLAB. Public institutions arrange contacts and resources (the Port of Rotterdam plays a major role (mainly during the establishment of RAMLAB) in

financing and allowed RAMLAB to use their network, Innovation Quarter helped them with submitting research proposals, application for funding and access to their network), the industry is seen as production locus (in RAMLAB their industrial partners loan their products, share their (specialized) knowledge and experiences) and academia provide the network with scientifically based research, knowledge and technology (universities and knowledge institutions contribute with conducting in-depth research executed by PhD students, highly trained engineers and postdocs). The above taken together results in a positive answer on the question if RAMLAB can be seen as a triple helix network. [6:✓]

Based of the above, it can be concluded that the RAMLAB network can be qualified as an innovation network, seen more specifically, as a triple helix network. All six questions could be answered positively.

Concluding, the aim of this chapter was to answer the second research question: ‘*What does the network of this case study look like?*’. The foregoing shows that RAMLAB is both a company and a network. This thesis focusses on the network, but an understanding of the company is required to understand what the network entails. RAMLAB the company initiated as a result of a research from 2014, where Wegener (manager of RAMLAB) was involved. RAMLAB’s aim is to make WAAM technology usable and working towards a future where metal parts can be printed on demand. Because of its technological complexities and high level of requested knowledge, collaboration is a prerequisite for developing WAAM. This led to the initiation of the network, where exchange of resources, in-depth knowledge and experiences inter-organizational learning stand central to advance WAAM. Currently the network consists of 26 organizations, with diverse and divergent specialisms centered around 3D-printing in the maritime sector. The network has achieved quite a lot in a short period of time, and in 2017 world's first certified 3D-printed propeller is manufactured, followed by a printed crane hook in 2018. These key events are driven by the exchange of knowledge, experience and resources of RAMLAB and its network members. Now, projects continue, as well as the development of WAAM technology, certification processes and case- and feasibility studies. A theoretical analysis showed that the network can be qualified both as an governance network and as innovation network, and more specifically as a triple helix network.

CHAPTER 5: ANALYSIS AND RESULTS

This chapter focuses on answering the third, fourth and fifth sub-questions of this research:

- *To what extent are factors that, according to the theory, influence collaboration, present in the case?;*
- *To what extent is good collaboration experienced in this case?;* and
- *Which of these factors can contribute to the explanation of the degree of (good) collaboration in this case?*

In §5.1 an analysis of good collaboration is presented. The independent variables from this research, the factors that influence collaboration, are discussed one by one. The insights and perceptions of the respondents are displayed here. In general, most respondents answered aligned with one another. Special or striking statements are highlighted, and also when answers contradicted. Then, in §5.2 the variables that are identified as most important are deliberated. These are the variables that the respondents weighed most heavily and that were mentioned most frequently.

5.1. Analysis of Good Collaboration

This analysis maintains the structure of the operationalization from §3.1. First the starting conditions will be discussed, then the institutional design, followed by the collaborative process and network management of RAMLAB. This aim of this analysis is to answer the question: *'To what extent are factors that, according to the theory, influence collaboration, present in the case?'*.

5.1.1. Starting conditions

As Chapter 2 showed, starting conditions set a basic level of trust, conflict and social capital for the upcoming collaboration. During the interviews the focus laid on three conditions: incentives or limitations to collaborate, imbalances between power or resources and the past history of cooperation or conflict. We begin with analyzing why actors joined the RAMLAB network, whereby the considerations between incentives or constraints on joining the network are taken into account. This question has been extensively answered by the respondents.

Incentives and constraints on participation

Participation in the RAMLAB network is on a voluntary basis. There is therefore no legal reason or obligation to join the network. In this research is only spoken with actors who have chosen to join the network, reasons for not participating in the network may therefore be underexposed. However, it is asked what a deterrent effect would be on participation, or what would be a reason for not participating.

The interviews show that a big incentive for joining the network is the knowledge that is available about the WAAM process in RAMLAB and the rapid progress that is made regarding WAAM. It is found attractive that RAMLAB consists of dedicated researchers and having high-quality knowledge in-house because of their PhD's and engineers from TU Delft and University of Twente. Another benefit members mention is the fact that RAMLAB bridges the gap between academia and industry, making the developments applicable. This is something they often miss in other consortia or R&D networks and experience as a shortcoming of those networks. In addition, members want to gain insights, stay updated about the developments of WAAM and want to ride along with this relatively new technology and innovation. Joining RAMLAB is therefore a relatively cheap manner to do so; the contribution is a lot cheaper than to develop this in their own organizations internally. Also, it is recognized that this type of innovation cannot be executed by only one actor, it is too complex and knowledge from multiple specialisms is necessary (called technological interdependency). Members know that they have a lot of knowledge about certain aspects and want to contribute to the development and stimulate the innovative, technical progress. Concepts mentioned hereby are synergy and symbiosis. The members mention that they share the vision of making WAAM bigger in the industry, which contributes to wanting to participating in RAMLAB. And, with an eye on the future, if 3D-printing becomes a success, the organizations are already involved and can benefit from the market. Furthermore, end-users learn what is and what is not possible with 3D-printing, and to what extent the technology is applicable to their needs and capabilities. At last, another incentive that is mentioned is the network function of RAMLAB. RAMLAB has built a large network of the maritime industry, which makes it easier for them to approach the right people and the network members don't have to invest in that

themselves thanks to their participation in RAMLAB. The network also facilitates the exchange of knowledge and experiences between members, this way knowledge can be shared, links can be made and opportunities arise. A respondent mentions many of the aforementioned incentives in the following statement:

“For us it is a relatively cheap way to stay up to date with this technology. Because as an alternative to doing it yourself, you have to have all the resources yourself, in terms of people and machines etc. [...] And an additional advantage is that if we want to make something, you can use the entire RAMLAB infrastructure. Plus we get to see all the results of that what RAMLAB does for others. Probably not everything, but good enough to keep an eye on the state of technology. Because RAMLAB is reasonably progressive in the field of technology, which has to do with the interaction of TU Delft, which guarantees the level of what they do. The technology therefore has certain quality and we are making progress.”

(Personal communication, 08-10-2019).

In the interviews also several constraints on participating in the RAMLAB network are mentioned. Primarily, if you want to join RAMLAB as an organization, you must own the necessary resources to participate. Next to paying an annual contribution, you also need enough manpower and time to participate in the meetings and process the transmitted knowledge, so, that according to the respondents, it is useful to join the network. This can form a threshold and can exclude small businesses. Making this investment can therefore be daunting, and it is possible that the investments made by the members do not pay off at all. This uncertainty can form another deterrent. A subsequent restraint is that if IPs are not well protected, they would feel reserved to participate. They want to maintain their competitive position in their industry and therefore the knowledge shared by members may not end up on the street and must be protected. Hooking in on this, having competition in the network also has a deterrent effect. Respondents explain that for them it is clear in advance that competition will lead to less successful cooperation and that it will obstruct openness, exchange and sharing between members. This is experienced as undesirable. However, management and rules anticipate on this, later on we will elaborate on this more. Another reason why members might not join the network is if RAMLAB will change its mission and vision. The progress of WAAM and the enthusiasm with which the team drives the developments are reasons for joining the network, but if this would change, it would be a reason not to join RAMLAB. And at last, when the technology is fully developed (when the technology is mature) and fundamental research is no longer necessary, some actors, such as M2i and Autodesk, feel that then their reason to contribute is no longer valid. They want to contribute to help RAMLAB, making WAAM a success and researching materials, without this they are losing their relevance, at their own discretion. However, they consider that it will take a long time before this happens.

But in summary, for many members it is attractive to join the network, the benefits outweigh the costs and if the network does not meet members' needs, they can always decide to leave RAMLAB, because it is voluntary and they are not (legally) tied to anything.

Power-Resource-Knowledge Symmetries

There are relatively big differences of inputs of resources the members bring in. It is free of obligation how much input you have to provide as a member, although it is stated by RAMLAB itself that they, and the network, will (of course) benefit most if as many input as possible is provided by as many members as possible. Seen from the theory it makes sense to think that RAMLAB and the most involved members possess most power within the network, but that is not entirely true. On one hand it is true, RAMLAB takes the most decisions as core of the network, sets the foundation and directs fundamental research. They are decisive in this, and the input, knowledge and experiences of the partners plays a guiding role. You can clearly see the role of RAMLAB as a lead organization here.

On the other hand, it is also stated that end-users have a controlling role in the developments, even though this is more within the projects that are running (and then paid by the end-users). Consequently, this could mean that a long period of time RAMLAB has to focus on what the end-user wants and this influences the center of gravity of the entire network. Furthermore, some respondents experience a dominant position of certification organizations. They must ultimately approve the products and methods of RAMLAB, but where WAAM must comply with has not yet been legally

established (because it is still so new and innovative). As a result, there are differences between the certifiers and this is by some perceived as subjective and that entails a certain dominant, powerful position for the certifiers. However, certifiers are external stakeholders. Furthermore, RAMLAB sometimes sees itself as the small party in the network that depends on others, and others can make use that. A large company, by way of example, after briefly taking part in RAMLAB, could take ('steal') the ideas and start the same research on its own. The chances of this are reduced by retaining the ownership of the overall picture of the process by RAMLAB and by (building) trust and trusting members.

Members (including partners and RAMLAB) see the difference in resource input not as something negative. There is a rational attitude towards this, that it is your own choice whether you want to invest a lot or a little, and that if you want to get more out of the network, you also have to invest more. If you only want to follow developments and gain knowledge through the meetings, then that is also fine. This also means that no manipulative effect is experienced and people feel that the network is in balance. A reason given for this is as follow:

"It is primarily a reasonable, friendly environment where everyone wants to participate in achieving a specific goal."

(Personal communication, 23-09-2019).

Prehistory of Cooperation or Conflict

When looking at previous collaboration between members before joining the RAMLAB network, they hadn't experienced any conflicts with each other. Some already knew one another beforehand and were for example each other's customers or worked together. Some members mention that they didn't really look into this, only to see if there were no competitors in the network, and if not, then it was not really important to them. Some also looked at previous cooperation to possibly bring in new members, or to make better connections between members who, until then, only knew each other vaguely. Most members only had positive associations, so the prehistory had a fostering function for the network. Therefore, as a result, no conflicts were mentioned that have arisen because of prior collaboration, and the trust level was not negatively influenced, but positively.

Furthermore, there was also a rational attitude towards previous cooperation, visible in the following quote:

"But theoretically, if there is a company with whom cooperation has been less, then you have to get over it. It is mainly about what they do with or for RAMLAB and then you should not be childish."

(Personal communication, 25-09-2019).

5.1.2. Institutional Design

As the literature of Chapter 2 showed, the institutional design refers to rules and scheme for collaboration, which is important, for among others, the legitimacy of the collaborative process. During the interviews the focus laid on five factors of the design: ground rules, network structure, participatory inclusiveness, forum exclusiveness and process transparency. We begin with analyzing what rules respondents experience in the RAMLAB network, where formal and informal rules are considered, and to which the most value is attached by the respondents. The other four parts will be analyzed subsequently.

Rules within the Network

The literature showed that having clear ground rules results in a more fair, open and just process, higher procedural legitimacy and trust building. When looking at ground rules in the RAMLAB network, respondents say that there are few to little agreements or (formal) rules that have been made.

"No restrictions are imposed by means of rules in the collaboration. Openness and freedom of action are central, questions can be asked and comments can be made."

(Personal communication, 30-09-2019).

In general, the network is therefore seen as a fairly informal network, where formal agreements are limited. Of course there are a number of rules, but little has been formally laid down with regard to contact standards or certain participation rules. However, where agreements have been made is about the knowledge, the process and the resources that are used. This is mainly written down in a Non-Disclosure Agreement (NDA) and Intellectual Property rights (IPs). Other rules or agreements that are mentioned are the sponsorship agreement and agreements for one-to-one projects. What has been agreed upon is experienced as something logical, in R&D projects this is a habit and mainly a formality. However, it also offers clarity and certainty and is therefore seen as valuable.

The sponsorship agreement forms the formal basis of the collaboration, which means that you have to pay a financial contribution that gives insights into the process and progress of RAMLAB. Thanks to the NDA and IPs, it is clearly agreed what can and cannot be shared within and outside of RAMLAB. This is on one hand for protecting the competitive position of the members themselves, because of NDA, members can easily share their knowledge and experiences within the network, but do not have to worry that their specialism will be out on the streets the next day. On the other hand, RAMLAB must also protect its position and keep the gained knowledge exclusively, otherwise the incentive to participate in the RAMLAB network is gone and then the RAMLAB company loses its business perspective and competitive advantage. When talking about agreements, the respondents mainly refer to the NDA and IP. These are the only agreements respondents pay attention to in the interviews and emphasize that they really consider this an important condition for collaboration and even for participating or not in the RAMLAB network, because there is a lot at stake. Agreements for one-to-one projects must also be made, which often concerns not only intended goals and results, but also who retains knowledge and what may and what may not be shared.

However, despite the fact that many respondents praise having few rules, because of its contribution to an informal working atmosphere and an often faster process, a critical point emerged during the interviews. What will happen if the technology is finished? Many respondents do not yet know an answer to this. It is unclear, and questions like: 'Should the members who contributed to the development also purchase their products for the full price?' or 'Do they receive part of the IP rights?' cannot be answered by them yet. If RAMLAB already has a plan for this, this has not yet been clearly communicated to the members. It is an uncertainty, but this uncertainty is by many shifted to the future, because: 'we are not that far yet'.

Additionally, there is also spoken about informal rules; when talking about informal rules, then informal principles or gentlemen agreements are mentioned:

"Just shake old-fashioned the hand on it. And you speak up your mind, yes. And honour your agreements."

(Personal communication, 20-09-2019).

In addition to this, members want the collaboration to be decent. So keep their word, use common sense, don't take advantage of each other, act to help and support RAMLAB as much as possible and have the intention to move the network forward, this way it benefits everyone as much as possible. This informality is also reflected in their preference for a network design; to open and honestly cooperation, with easygoing and fast communication.

"Having that open sphere, in this case it has been semi-informal and relaxed I think, which is really good."

(Personal communication, 18-10-2019).

Finishing, in general it is experienced that little rules exist and it is mentioned that having few rules and agreements is a conscious choice, a choice for design. For this type of network, many agreements and rules often only oppose and slow down the process. This while the network wants to make rapid progress. That is why many members are satisfied with how the network is arranged in terms of rules; it is seen as clear and logical, and informal principles also play a role in this. A disadvantage of having few rules is that certain aspects of the process or collaboration have not yet been discussed, these parts remain vague and this creates uncertainty about the future.

Network structure

Following from the interviews a three level structure of the RAMLAB network can be composed: the RAMLAB company as the core of the network, followed by a layer of partners and a third layer of members. Not everyone made this distinction between the partners and the members, some called all the related actors simply ‘members’, others called them ‘partners’. In the next quotation you can see a description of the distinction made by a respondent:

“There are different levels. So partners are key to the RAMLAB success, partners like Valk Welding, Autodesk and I believe there are a few others as well who are there who contribute to RAMLAB. And there are members who are there to either work with RAMLAB or to work for them or just to be there and just to learn, right?”

(Personal communication, 18-10-2019).

The key partners are prominent and crucial for progress and development of RAMLAB, while members are often connected to the network for another reason, such as organizational-learning, ‘*don’t want to miss the boat*’ and staying up to date about 3D-printing. In Appendix III you can find an overview of this division, based on their website and the interviews (3 initiators, 5 partners, 2 academic partners and 16 members). However, in general shall be spoken of network members in this thesis, since that includes all levels of the network: the members, partners and the RAMLAB company itself.

Another structural feature of the network is that the RAMLAB company is seen as the core of the network. In the interviews the company is several times cited as the connecting link, the dot or described as following:

“RAMLAB can be seen as the spider of the web, that ensures that all wires stay connected.”

(Personal communication, 30-09-2019).

They are seen as a glue that keeps the network together, the link that takes a leading role and often Vincent Wegener, the Managing Director of the RAMLAB company, is seen as the personification of this. The respondents argue that it makes sense that this role is reserved for the company, because the core activities take place in the company and developments are the property of the RAMLAB company. When considering the literature of Provan & Kenis (2007), you may say that RAMLAB corresponds with their Lead Organisation type. This type implies that the network is highly centralized and brokered, main activities and key decisions are coordinated by the brokering organisation (RAMLAB), and administration and facilitating is provided by them. There is little member-to-member interaction, one single organization (RAMLAB) acts as a leading organization and plays a critical role for the maintenance and survival of the network. This corresponds with the insights obtained from the interviews, but also fits the previously discussed hub firm-perspective of Dhanaraj & Parkhe (2006). According to them the hub firm has a ‘subtle leadership’ position, whereby they are appointed to support and facilitate the network and have to gather the distributed competences and resources of the network members. The members are seen as active, rational actors who take effective, calculated and determined actions. This description also fits well with the reality of RAMLAB and hereby describes a part of the structure and division of roles within the network. This leads to the following visualization of the RAMLAB network:

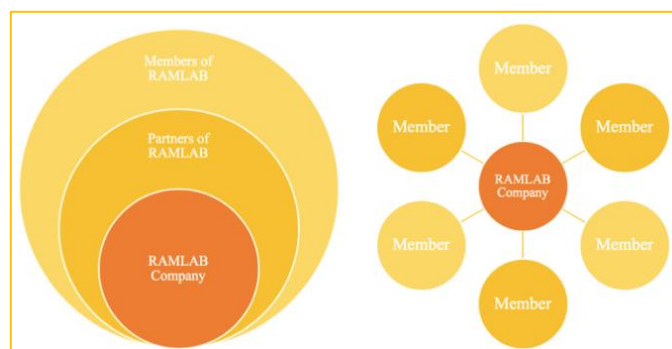


Figure 7. Structure of the RAMLAB network

The literature shows that innovation networks often have no fixed roles or functions for its members. Formal hierarchy is absent and the roles people or organizations adopt depend on the nature of the required resources and on their involvement in the process. In RAMLAB you also see that there are no fixed functions, participation is voluntary and thereby no obligations or positions are imposed. This is experienced as a correct way of working in an innovative network or context.

“Everyone has their own tasks, focus and specialism and this is linked to each other. This is a very good structure for research-like or innovative collaboration networks. That way you can do projects together and see what works and what doesn’t.”

(Personal communication, 25-09-2019).

In the theoretical analysis of Chapter 4 the network's structure was partly discussed. It emerged RAMLAB matched the characteristics of a triple helix collaboration, with the inclusion of private, public and academical sector. Looking further at the structure of this network, it is possible to look at whether all types of actors are involved in the process. This refers to all actors of the value chain for achieving innovation. The interviews show that it is taken into account who is admitted to the network and specialisms who are in demand are actively sought. When a specific gas specialist is requested, they seek a gas supplier that may be of use and approach them. At this moment it seems that all necessary actors are present in the network, for instance suppliers of raw materials, products, knowledge, end-users, etc.

Process Transparency

The third institutional factor concerns process transparency. Process transparency means mainly that stakeholders experience the process as ‘real’ and are able to see the whole process with certain clarity, and not get the feeling that this is happening behind closed doors. The members of RAMLAB indicate that transparency within the collaboration is of great importance to them. It is said that the meetings contribute to a transparent process, because here the progress and results are shared and one can openly ask questions and clear answers are provided. RAMLAB acts openly and that is easily linked to transparency. One member voices this as following:

“The process has to be open, free and in a fair way. There needs to be transparency. Transparency is preferred in collaboration.”

(Personal communication, 30-09-2019).

Openness and transparency are often referred to together by respondents. A further explanation given by this is that the open acting of actors results in a feeling that interaction takes place in a transparent way, that RAMLAB and its members are openly sharing and therefore act fairly. The combination of open and transparent acting results, according to the respondents, to more trust in each other and in RAMLAB, which in turn contributes to the desire to do better and to help RAMLAB more, which, in their opinion, results in more success and better cooperation.

However, RAMLAB is also less transparent in some areas. As mentioned earlier, there are IPs and NDAs. Certain knowledge that is gained during one-to-one projects can therefore not be shared.

These processes are consequently not completely accessible for everyone, so you can say that they do not act transparently. However, it is mentioned that agreements have been made about this and that everyone is aware of them. In line with this, RAMLAB cannot share everything either because they have to keep their competitive advantage. They must keep certain knowledge to themselves in order to remain relevant as an organization and network. Furthermore, the decision-making process is also not entirely transparent. The decision-making lies with the RAMLAB company itself and they determine the direction of the developments. One can give his opinion and this may also be requested, but the final decision lies with RAMLAB. Additionally, it is also mentioned that if there are disagreements, this sort of thing is dealt with behind closed doors. The members don't get that much out of it. This can be experienced as less transparent, but according to them it does contribute to professionalism.

However, some members wonder if it is necessary that you know about everything. According to them, some things are not relevant to the network itself, so that information can then remain only within RAMLAB company and does not need to be shared. The main thing is to be transparent about the results and progress of the WAAM process. The point is that you get the big picture, and they experience that this is the case and are positive about it.

Participatory Inclusiveness

The fourth institutional factor is the participatory inclusiveness of the network. Participatory inclusiveness concerns the question whether or not the network is accessible for anyone who has an interest in joining the network. The literature states a positive relation between inclusiveness and successful collaboration. One could argue that RAMLAB is not fully inclusive, based on two arguments. First of all, it is reported that RAMLAB is actively excluding stakeholders from joining the network. The literature states that actively excluding actors can be seen as a factor of failure and threat to the legitimacy of the process, however, members disagree. By excluding certain actors, competition is kept out of the network. Members see this as a major advantage for the collaboration, as mentioned earlier, competition shall lead to people leaving the network or at least acting much more closed and sharing less information, knowledge and experiences. Excluding stakeholders prevents friction, it continues members to communicate more openly and to contribute to the network by sharing their own resources.

“If there were competing parties in the network, you should be more careful with what you share and what you say. Not being each other's competitors contributes to easier knowledge sharing and occasionally showing something.”

(Personal communication, 25-09-2019).

There is a second reason why RAMLAB can be seen as non-inclusive. There are organizations that want to participate in the network, but do not have the resources to do so. There is an annual contribution that must be paid, which is a hard condition. If you cannot pay, you will automatically be excluded. The exclusion of certain stakeholders is seen as something positive by members, they find it common sense that everyone has to contribute. But it is not only about this financial contribution, it is also about the time that has to be invested (for example attending the meetings or answering mail or Whatsapp). You must possess human resources to participate in the network and to benefit from your participation, for example. It is mentioned in the interviews that for this reason smaller companies had to drop out because they did not have enough resources to invest and the annual contribution was too much for them.

Where the literature says that for achieving good collaboration the participatory inclusiveness should be as high as possible, this network states the opposite. They see actively excluding actors from participation, and thereby excluding competition from the network as a good (maybe even necessary) management strategy and encourage this. They consider inclusiveness not to be a success factor for good collaboration, but find it necessary to actively exclude certain actors and see it as common sense that you need a certain level of resources to participate.

Forum Exclusiveness

Forum exclusiveness is about being the 'only player present in town', where alternative forums are limited or non-existing. The more exclusive the forum, the higher the chance that stakeholders want to

collaborate with you. When considering RAMLAB, there is a small number of alternatives, looking world-wide. During the interviews a number of times a reference was made to a network in Amsterdam that also prints 3D with metals, and a network in America that does something similar to RAMLAB. However, respondents emphasize their preference on RAMLAB because on one hand it is geographically located in Rotterdam, the Netherlands, and an alternative in America has multiple cons because of their location (far away), and RAMLAB has several pros because it is located in a maritime area, the port and most members are relatively close located. In addition, it is frequently emphasized that RAMLAB is very professional, has high-quality knowledge (because of PhDs and TU Delft and Twente graduates) and can make this knowledge applicable for the maritime sector. These arguments are presented as to why they opt for RAMLAB and not for, for example, the network in Amsterdam, who is also relatively nearby.

“Yes, I think they work much better in Rotterdam because they actually do research there, into materials, structures, things like that. And there in Amsterdam they printed a bridge and that entire bridge collapsed.”

(Personal communication, 26-09-2019).

It can be said that RAMLAB has quite an exclusive forum, there are very limited alternatives, but these alternatives have a focal point that lays somewhere else and they have a different level of quality than RAMLAB.

5.1.3. Collaborative Process

The collaborative process is where the actual collaboration is taking place. In Chapter 2 three models are presented in the collaborative process, the collaborative process of Ansell & Gash (2007), the framework of collaboration of innovation networks of Morrà (2015) and the triple helix model. The structure of the model of Ansell & Gash has largely been retained, starting with resource and knowledge exchange, face-to-face dialogue, intermediate outcomes, trust and trust-building, commitment to the process and having a shared understanding. At last, an factor is added: ‘people of RAMLAB’. This factor emerged very clearly from the interviews, and was considered important by the respondents; therefore it had to be added. There was no suitable denominator under which this factor could fall, but interviews did show that this factor was part of the collaborative process.

Resource and Knowledge exchange

Chapter 2 showed that innovation networks are sometimes called ‘networks of learning’, which reflects the, often seen, purpose of innovation networks: producing or developing innovation by the pooling of resources and knowledge that were otherwise unavailable. Terms of synergy, complementarity and inter-organizational learning are related to this.

When asking the respondents about resource exchange and knowledge, they indicate that knowledge is the most important asset of this network. They emphasize that RAMLAB contains a lot of high-quality knowledge, which is created by the level of researchers and engineers, who are very skilled and study WAAM extensively, combined with the experiences and specialisms of the network members, who all have their skills in their discipline. The gained knowledge of RAMLAB in WAAM has to be protected to contain their competitive advantage. Respondents tell that RAMLAB handles this professionally, that there is a fast pace in further knowledge development, and that RAMLAB knows a lot about materials, structure, robotics...; about the whole value chain. In addition, there is looked at how this knowledge can be implemented and applied in practice, and a match can be found between the metallurgy and the product. That is the strength of the network and why, according to the respondents, this way of a collaboration working well.

“Exchange of resources and knowledge is important. We build WAAM and knowledge together in RAMLAB.”

(Personal communication, 11-03-2019).

According to respondents, the reason that RAMLAB possesses this bundle of knowledge is largely due to knowledge transfer. In meetings, one-to-one projects and by simply contacting each other, knowledge is transferred. It often happens that a problem arises during a project at RAMLAB, and they contact the network member who has this specific knowledge. For example, when questions rise about offline programming of robot paths Valk Welding is contacted, questions about certain material types arrive at Voestalpine and challenges in software are deposited by Autodesk. This clearly shows that knowledge is divided between the different members, and that pooling of resources is actually necessary to make innovative progress. The following quote endorses this:

“You need a lot of resources to realize this technique. If you have to get all this yourself, it is a gigantic project and it costs a lot. Now you can share each other's resources and get through the process together. It is a great advantage that you can exchange cross-sectoral knowledge and experiences within the network.”

(Personal communication, 08-10-2019).

Furthermore, during the process they continue to encounter obstacles that need to be overcome. By involving each other in these challenges, they learn from each other gradually and you see the concept of inter-organizational learning in practice. In addition, it is seen as an advantage that, thanks to their participation in the network, they not only learn from each other, but also from each other's industry and gain potential benefits for their own sector.

Synergy and complementarity are also often mentioned concepts of innovation networks. They can also be recognized in the collaborative process of RAMLAB. It is endorsed by several respondents that the pooling of their resources results in greater opportunities than the sum of their own, separate abilities could create. Respondents say that they are open to ‘exploiting’ each other in this network, which means that they want to make real use of each other's abilities and resources, because, in their opinion, the network benefits most that way. And if the network benefits, the chances are that their organization themselves will benefit as well in the future.

“You have to complement each other, make use of each other, give feedback to each other and learn from it. That is how you evolve.”

(Personal communication, 30-09-2019).

Face-to-Face Dialogue and the Interaction Process

The literature showed that having face-to-face dialogue involves listening to each other, exploring ideas and finding common ground. When asking respondents about this, most refer directly to the meetings that are organized once every three months at the RDM-yard. Many benefits were mentioned with regard to the gatherings. First of all, this gives the possibility to share and exchange knowledge, which is very important to them as innovative network. Based on presentations, current progress and gained knowledge is pitched and a summary of current projects is given. Due to the physical presence of the members, everyone can give feedback, discuss and ask questions directly, making the interaction process smoother than, for example, via e-mail or telephone. From RAMLAB's perspective, it is also seen as a moment to motivate and activate members. Moreover, the meetings are also the time for members to catch up, to present certain issues to each other (so that use is made of each other's expertise and knowledge), ideas are gained for subsequent projects or projects between the organizations apart from RAMLAB. When you get there:

“You get new ideas, new thoughts and new inspiration, for sure.”

(Personal communication, 18-10-2019).

These interactions often take place during coffee moments and (lunch) breaks. This is referred to as the network moment, where the network function of RAMLAB shows. In addition to the knowledge exchange and updates on the progress of WAAM, respondents also see the network function of RAMLAB as a big advantage of the collaboration. This way they can spar with people from their sector, who often look at problems from a different angle. This way, one's own insight is broadened and various

solutions can be proposed. The networking is deliberately kept informal by RAMLAB, because it is said to be more pleasant and this way more interesting than formal meetings.

“Yes people have to see each other. Physical contact is very important to me. Those quarterly meetings really contribute to the collaboration. So organize those meetings, that everyone comes together, in the meantime drink coffee and get a sandwich. This provides space for non-project-oriented space, then possibilities arise.”

(Personal communication, 23-09-2019).

The meetings also provide time so RAMLAB can run into people and ask if they can come and have a look at something and give their advice. Preference is generally given to face-to-face joint problem solving, also outside of meetings. For example, employees indicate that face-to-face solving works a lot faster, better and is more efficient. It has a positive effect on the relationship of those who work together, making them feel more connected and involved, which increases trust.

“It is also really important. Sometimes a problem cannot be solved by mail, you need people that actually be there, you need a practical approach. So when something is wrong in the process, don't solve it by phone of email, but come over and just do it together.”

(Personal communication, 01-11-2019).

The literature showed that good faith negotiation was also an important aspect of face-to-face dialogue. Negotiating in good faith is to negotiate honestly and fair, pursuing mutual benefits and the aim is to find common grounds and negotiations resulting in agreements.

It emerges from the interviews that everyone acts according to good faith, or at least thinks that good faith is acted upon. Several respondents emphasize numerous times that they want to advance the technology as quickly and effectively as possible, that they want to help RAMLAB as good as possible and that they see that if the technology can actually become what they have in mind, there are possibilities that benefits themselves and others. Mutual benefits are being sought in that regard.

Intermediate Outcomes and Innovation

The third factor concerns intermediate outcomes. Intermediate outcomes can visualise potential goals, increase the attractiveness to participate and contribute to a shared perception. This by achieving and acknowledging small wins, providing strategic plans and joint-fact finding.

Beginning with the small (innovative) wins of the RAMLAB network. The development of the technology goes, in its own words, with peaks and valleys. However, mainly in the initial period, the peaks predominated. The technology developed very quickly, and soon RAMLAB managed to print the propeller and get it certified. The small wins led to the big wins, because the technology had to be developed step by step. Small (and big) wins have contributed to more people joining the network, when viewing RAMLAB as successful, confidence in the abilities of RAMLAB grows and people want to participate. Another advantage that is mentioned in the interviews, resulting from intermediate outcomes, is gaining publicity. For example, the news is made several times with the WAAM technology (even the Guinness Book of Records) and organizations associated with RAMLAB are mentioned in the news, often an innovative label is thereby affixed to their organization, which they often pursue. It is also mentioned that showing progress and emphasizing wins forms an incentive for continuing to work together. Seeing results contributes that way to better collaboration. End-users cite the results of one-to-one projects. The results found here are said to always be a win, even if the results are not positive; finding that something is not working is also a step closer to the right solution. A bigger stumbling-block that RAMLAB is currently facing (November 2019) is the certification process, this is not going too well at this moment and offers the necessary challenges.

Providing strategic plans contributes to concretizing goals, which adds to the collaborative process. Yet, having a strategic plan was not discussed much in the interviews. RAMLAB has clearly formulated its mission and vision, and many respondents indicate that they support this. This will be discussed further with the fifth variable: shared understanding. Respondents do not elaborate on strategic plans in too much detail, and therefore it appears to be less relevant to them than other factors. However,

it is emphasized that RAMLAB must continue to look ahead and that it would also be nice if the news would be made again with great success (but there is confidence in that).

Then the third element of intermediate outcomes: joint-fact finding. This is a method that allows actors to work together on knowledge development. This is considered extremely important in this network. It can be seen as the core of the network and the purpose of the collaboration: advancing WAAM technology. This can only be done by joining forces, because of their interdependencies, complementary relations and complexity of the process. Almost all respondents cite that joint-fact finding is one of the most essential reasons for joining the network. The process of researching, developing and receiving knowledge, discussing this, let all the members, especially partners, shine their expertise on this, discuss it with the relevant actors (on meetings or by contacting them) and making progress in the development process. The aim of joint-fact finding is to arrive at a shared perception of knowledge. In this network, this process of arriving at a shared perception of knowledge is supported by doing tests and investigations in the MakerSpace at the RDM-yard. The shared perception in the field of knowledge is stimulated by the knowledge and research of the engineers and PhD's, with the addition from practice by the members. This creates a mix that together leads to a perception of knowledge. It is an incremental process that continues to evolve over time.

Trust and Trust-Building

Then, the fourth factor is trust-building. In the literature, trust is often seen as an important factor of good collaboration. The influence of trust is visible in multiple areas, for example, trust leads to more predictability and stability within a network, knowledge and resources are easier shared, inter-organizational learning improves and risks and costs are reduced. In an innovative context, where outcomes are not foreseeable, risks are high and benefits uncertain, trust can therefore be of extra importance and play a reassuring role. Besides, trust is important for a collaboration to result in innovation or not.

Respondents state that they consider trust to be (very) important and that it is present in the RAMLAB network. Some state that trust can be seen as one of the most important things for good collaboration. Trust is needed for achieving progress, especially when it comes to innovative technology where sensitive information is discussed. There must be a certain degree of trust within the network to dare and be willing to share information and resources with others. You have to trust that it stays within the network, which is of course partly established by NDAs and IPs, but the other part is based on trust between members.

“Without trust, you won't get far. If you want to have an open network, then you have to have a certain amount of trust in each other.”

(Personal communication, 23-09-2019).

However, respondents make a side note. Trust in each other and the network is certainly present, but the question must be raised how intensively they work together that high levels of trust are necessary. Most interaction and pooling of resources occurs with the RAMLAB company, with which agreements have been made and for RAMLAB company there is a lot at stake when harming the trust of members (it is RAMLAB's core business, for the members more often an (interesting) side path); it is therefore less likely that RAMLAB will damage their trust. The interaction patterns with the other members is a lot less, which results in a less intense relationship and sharing of sensitive information is therefore limited and high levels of trust are consequently less necessary. The nuance is also applied in the amount of trust you have, you do not have to tell everything and be completely open. You should always keep your own organization in mind. But you have to be open and honest to the extent that it promotes WAAM and the network.

How is this trust built according to the respondents? You have to build trust and trust in the persons you work with. You do this by being honest, direct and open. You have to mention the things that need to be mentioned; to say things like they are. That you are honest about your intentions and that expressing them is not a taboo. Here too, the role of competition, the conscious exclusion of competition and staying out of contact with competition, is clearly evident. It is mentioned that it is easier to trust each other because they are not competitive with each other, that thanks to the IPs and NDAs they are

also not afraid that sensitive information will be shared with competition and that they therefore see no limitation to share things and to be open about their business. They also mention that the informal atmosphere contributes to this, when you are more at ease, it is easier to build trust and to strengthen relationships. And at last, trust is also built because they believe in the abilities of RAMLAB. They are confident that RAMLAB is doing the best they can, by working professionally, open and evidence based (a scientific approach). They provide insight into progress, in intermediate outcomes, they involve you in the process, they always answer your questions and share the things they do. But also because of their professional approach, through the research they do into every part of the process and through the high-level of knowledge that is available to the employees. This gives confidence in RAMLAB and therefore respondents entrust them with the process. Also the location where RAMLAB is situated plays a role, the MakerSpace looks inspiring and professionally, which contributes to the sense of striving for innovative progress and opportunities.

You can say that trust is seen as an important condition for good collaboration and that trust is present. Respondents trust each other, but emphasize that in particular the trust relationship with RAMLAB company plays a major role. This is for the most part fostered by their professional and open approach. Trust among members is strengthened by building mutual contact, excluding competition and having an open and honest attitude towards each other.

Commitment to the Process

The fifth factor concerns the commitment to the process. Commitment facilitates the collaborative process and can form a critical factor for success or failure of the collaborative process. In the literature three conditions that contribute to commitment have been discussed: mutual recognition of interdependence, shared ownership of the process and exploring mutual gains.

Interdependency means being mutually reliant on each other. Besides the fact that it is a characteristic of innovation networks, we have also seen in the literature that it is a general tendency, and that, as society becomes more complex, more and more interdependencies arise. Since there are the necessary complexities of developing WAAM, interdependencies can also be observed in the RAMLAB network. The following quote is quite long, but gives a very clear overview of how the interdependency takes place:

“From hardware, software, controlling machines, figure out who the end-users are, what they actually want, marketing, sales, all these things. It is quite a multidisciplinary thing, and RAMLAB does not have all the resources to do this all by themselves. They are a very small group and they don't need to do all those things by themselves, we can help for instance. And the same reason why other partners are there is that, RAMLAB does not want to make all the materials, but there are partners that make the materials and then together, they don't want to write their own software, because we do that, so we can do help them, and so forth. So it would be a win-win-win across the group, and again, in this haven, in this open space, where people can come and discuss and interact and look at problems, is really helpful.”

(Personal communication, 18-10-2019).

This quote reflects the many disciplines and the diverse expertise that is necessary for developing WAAM, who are not present at the same time by only one actor, or at RAMLAB. This is why the members need and are mutually dependent on one another, and by recognizing these interdependencies the 3D-printing process can be advanced. The terms synergy, symbiosis and technological interdependencies are related to this in the interviews. One respondent expresses that the network has to complement each other, that make use of each other, give feedback and mutually learn from it. This way he describes interdependency as a cross-pollination, where you mutually influence each other. The literature states that when actors recognize their interdependent status, it encourages the desire to contribute and commit to more meaningful collaboration. That is also the feeling that can be deduced from the interviews. In addition, this also means that people are more likely to investigate mutual gains, which in turn contributes to more commitment.

In the network exploring mutual gains is almost seen as a condition to participate. It is very clearly stated that this collaboration must be a win-win situation for all parties. This has also emerged in the starting conditions, where incentives to participate have been discussed. People really want to

help RAMLAB and the technology, they see the benefits for the industry, for the maritime sector; but there must also be something to be gained for your own organization. And everyone is clear about that. It is emphasized that it is important that everyone sees their own interest, which is why you stay in the network and keep working together. This allows you to set joint goals and this encourages to achieve them.

“You have to make it together and together you have to get further together. If you keep it interesting for both, then you keep the collaboration good.”

(Personal communication, 20-09-2019).

Mentioned mutual gains are the cross-sectoral exchange of knowledge and experiences, the joint processes, the symbiotic collaboration, network expansion, the synergy of the learning and developing process. Respondents emphasize the importance of a joint learning process and the knowledge that results from this. For some, the gain lies in the future, and is therefore still an uncertainty and a risk (‘shall the investments eventually pay off?’), for end-users the gain is closer, because they immediately see the results of the one-to-one projects.

Then the last condition that contributes to commitment is arriving at a shared ownership of the process. The answer to this question can actually go two ways. On the one hand, the respondents feel a shared responsibility of the process. They want to contribute and know that if they step back the process slows down and the developments of WAAM may linger. Several respondents say that they regularly go to the RDM MakerSpace to look at the developments, to help where necessary and to solve the problems together (the face-to-face problem solving, which was discussed during face-to-face dialogue). Members feel and take responsibility in the process in that regard, and therefore experience shared ownership. On the other hand, it is also mentioned that they really consider RAMLAB company to be responsible for the network, both the maintenance of the network and the progress and process of WAAM. So here you can see that the ownership of the process is being abandoned. You also notice this in the way they talk about progress, for example, they offer their help to RAMLAB company, they see it as a service to RAMLAB, instead of seeing it to a service to the entire network. What may be related to this is that RAMLAB also has the IP rights, it is their core activity and the work takes place at their workplace; many factors that can play a role by making them more responsible. A visualization that emerged from the interviews was that everyone delivers their puzzle piece and that RAMLAB must assemble the puzzle before you can see the total picture. In this metaphor you can find their interdependence (everyone has to contribute a piece, alone you won’t be able to complete the puzzle), the mutual gains (you need all the pieces to make the puzzle and see the total picture/puzzle) and the ownership that lies with RAMLAB (RAMLAB must put the pieces together) coming back as well as.

Something else that is linked to commitment is the following:

“What is the commitment? That you go to those meetings? And? It is fairly non-binding. We do a case with them because we want it ourselves, and not because we have to. But I will not go directly to a company other than RAMLAB if I want to print something from steel.”

(Personal communication, 25-09-2019).

The interview runs a bit further and you actually notice that the commitment is also partly linked to a certain loyalty. Parts of the services offered can also be performed by others, but there is still a form of loyalty to stay at RAMLAB. So you see that forum exclusiveness in combination with loyalty or commitment can play a role in this. What is further mentioned is that there is more commitment to RAMLAB company than overall commitment to all members or to the network itself. This also corresponds to the fact that people mainly experience the collaboration between them and RAMLAB company than that it really feels like a collaboration between members.

In general you can conclude that the members find commitment important for good collaboration. Especially intrinsic motivation and creating mutual gains are contributing factors, appears from the interviews. Particularly when considering:

“Everyone is busy with his/her company and all those people are super busy and find it [WAAM] all very interesting. [...] There is no real market yet, so people are willing to invest, but to put in extra time after their own permanent job, then you ask quite a bit. ”

(Personal communication, 01-11-2019).

Shared Understanding

Then, the sixth factor of the collaborative process is having a shared understanding. Three conditions contribute to having a better shared understanding within you collaboration, which are defining a clear mission, identifying common values and formulating a common problem definition. The interviews show that the mission and vision are shared among the network members. Respondents all give roughly the same meaning when asked about their mission and vision within RAMLAB: to gain knowledge about 3D-printing and making WAAM a success. The following two quotes show this:

“We all have a goal, there may be small differences, but we all have one goal: achieving to make WAAM a success. Making WAAM successful.”

(Personal communication, 30-09-2019).

“We do have a shared vision, this is to see the large scale additive manufacturing become a part of the industry. This is the underlining mission that we have and want to continue to work towards.”

(Personal communication, 08-10-2019).

People experience that all noses of the members point in the same direction (*“de neuzen wijzen in dezelfde richting”*), and that they want to work jointly towards the same goals. This is seen as another factor that reinforces cooperation. It is mentioned that this is partly due to the enthusiasm that people have for achieving the goal, that they want to learn, that they strive to make WAAM technology a success, and that this makes the collaboration work.

Having a shared vision is experienced as important. Some find this incredibly important, others find it a bit less important. It is acknowledged that this shared vision is more strongly shared by people who are more involved in the process, especially the partners and end-users. The members who are mainly interested in learning and receiving updates about WAAM, of course, have the intention that WAAM progresses and the technology develops as quickly as possible, but they contribute less to this directly. In addition, the vision also provides direction for the future and it is this way more clear to members where they are working towards, which leads to clarity and therefore to more stability in the network. It is recognized that people view their goals from their own point of view, but the vision in general is shared. If this would not be so, members think it would have a counteracting effect on the collaboration.

Different values are casually mentioned in the interviews. Some are not explicitly said when questioning a shared understanding. But values that are mentioned several times by multiple people, and therefore can be seen as shared values of this network are: wanting to have and creating high-quality knowledge and learning process, clear and smooth (*vlotte*) mutual communication, having an open, honest attitude towards each other and help each other (and especially RAMLAB) where possible. The value that is attached to the high-quality knowledge and the learning process stems from statements about RAMLAB employees, who are praised for being *“very smart, those guys from the TU”* and that much value is attached to the fact that they have a high academical degree and that they form the basis of the developments together with engineers. Members value this. Working with an open attitude, where people want to exchange as much as possible to get ahead and are honest, is also mentioned by many people. This will be discussed in the next section *“people of RAMLAB”* and is also partly discussed in the foregoing. What contributes to this is according to the respondents is the fact that the collaborative process is largely informal and relaxed, caused by the attitude of members and because they work for the same purpose, with largely the same values, which in turn leads to better cooperation in general.

People of RAMLAB

The seventh and last factor of the collaborative process is the *“People of RAMLAB”*. This variable has special value because it does not come forward from literature but is created after conducting the

interviews. The respondents spoke about it during the interviews and gave great value to it: they saw the people of RAMLAB as a factor that contributed to the good collaboration of the network. What is exactly meant by this?

This is largely about the attitude of the members. When respondents are asked what truly makes the collaboration function well, many respondents mention that the attitude of the members are decisive.

“You need enthusiastic people to have good cooperation. They are motivated to push the technology further. [...] People are very important. In any network. People are the key I think.”

(Personal communication, 23-09-2019).

In addition to this statement, references are also made to having a creative spirit that moves boundaries, having a collaborative mindset, a having proactive attitude, being highly motivated and dedicated. For example, respondents say that it can really make a difference when people are intrinsic motivated, when they really want to contribute and make a difference, when they are motivated to share their knowledge and resources and want to learn from each other. Having a shared mission and vision contributes to this, but also the way of communicating seems important. If a question is asked, it is conducive if a response comes quickly and you do not have to wait for one or two weeks; this slows the process down and takes you out of the subject. It is also said that the informal way of interacting with each other supports this, which ensures that the connection is easier and that you are more open to each other and you don't have to be reticent. In addition to being open to each other and having an open attitude, honesty and transparency are also seen as behavioral characteristics that promote collaboration. Another mentality or attitude that is mentioned is the "Rotterdam mentality"; many of the affiliated organizations are located in Rotterdam (port of Rotterdam) and environs. What is meant by this is that people have to put words into action (*‘niet lullen maar poetsen’*), so do not keep up appearances, but actually do what you have said, make your words come true and also be reasonably direct towards each other (which is often seen as a characteristic of Dutch culture, but is also often linked to a Rotterdam culture/mentality).

Which is partly related to the attitude of people, but earns a special place because it is often mentioned separately the ‘deserve factor’ (*‘gunfactor’*). There is not a really good translation available for this, but the Dutch dictionary describes *gunnen* as liking that someone has something or gets something. The interviews show that most members really want RAMLAB and WAAM to succeed and they want to contribute to this. It is said that sometimes you have to do something, without immediately expecting something in return; you have to grand (*gun*) them. This may imply that certain members lend out certain items or provide certain services for which an invoice would normally be made. They recognize that it will not work that way, sometimes the capital is not there, sometimes you just have to give them a move in the right direction without receiving immediate a benefit in return. This is based on the confidence in RAMLAB and on the hope or expectation that it will pay for itself in the long term. And this is not only aimed at RAMLAB (for the most part it is, in favor of WAAM), but sometimes also reciprocally or RAMLAB provides the organization with a service, for example by giving a tour to relations of that organization on the RDM yard. This deserve factor is seen as factor that contributes to the networks success and the shared mission to make WAAM successful.

“We always like when people are willing to help others and teach others. We believe in the network effect, so if one person shares with another, than they show that you have a much broader and more enriched environment to work in.”

(Personal communication, 18-10-2019).

It is also mentioned that it is stimulating that the network consists of a group that is varied in people and background. This ensures diversity of thought and opinion, what enhances creativity and unique solutions.

And at last, the people of RAMLAB also includes the professionals of RAMLAB. The respondents endorse that because RAMLAB consists of people who really have a lot of knowledge about WAAM and the associated processes, they believe that RAMLAB can actually make WAAM a success. They are seen as the knowledge carriers of the network and they generate a lot of confidence in the company and in the progress of developments.

The previous section discussed the collaborative process of RAMLAB, where seven sub-variables were discussed. Now, the last variable of this analysis will be considered: network management.

5.1.4. Network Management

In Chapter 2 it was discussed that network management is defined as strategies aimed at facilitating and guiding interactions, a form of (indirect) steering that focusses on dealing with complexities and uncertainties by influencing strategic actions of network members. The literature shows that network management is very important for a network, its processes, performances and outcomes. Here the network management of RAMLAB is examined, beginning with general management strategies, followed by management strategies focused on innovation and knowledge and thereafter attention is paid to the role of network manager in this network.

General Management Strategies

The respondents all support the statement from Chapter 2: network management is found to be very important. They mention that without network management, the network would fall apart. The argument that network management creates an arena for collaboration is confirmed in the RAMLAB network. RAMLAB must maintain the network and they are designated to be responsible for this; RAMLAB company set the network up, so they have to retain it. They have to have this facilitative and guiding role in the network, and the importance of this is also endorsed:

“Without management you would have no partners, so meetings are important, maintaining active contact with partners and the building of relationships and trust.”

(Personal communication, 01-11-2019).

When respondents were asked what kind of management strategies they experience, they generally mention organizing quarterly meetings, providing updates on progress and current projects, the functioning as contact point for staff and members, maintaining contact, prioritizing of strategic choices and managing the projects.

An interesting answer that is mentioned by the respondent is the chosen location by RAMLAB. Members find the decision to position RAMLAB in the Innovation Dock at the RDM yard particularly well made. On the one hand, it is well chosen in terms of geographical location. It is easily accessible, most participating organizations are located in Rotterdam and the surrounding area so they can quickly drop by. And, it is positioned at the port of Rotterdam, which directly shows the industry you are working for and it visualizes where you are working for. On the other hand, respondents applaud the aesthetics of the scenery; they find this place inspiring, that whenever you arrive you instantly are motivated to innovate, that it stimulates interaction and makes you think something is happening. The following statements show this:

“They become a light house for the industry to say 'Look, it can be done! This is possible, come and look, and see what we have done!' So as a site, it is great thing to show the industry. [...] It is a great space to have people meet, discuss and talk. Even just having this building in what RAMLAB sits, it is just fantastic, it is just lovely, right? So it is of great value.”

(Personal communication, 18-10-2019).

In addition to the location, the extent to which publicity is achieved and the realization of good PR for RAMLAB and its members is also discussed. RAMLAB is said to be good at getting media attention, and respondents see this positive publicity for their company as a convenient side effect of their participation. Furthermore, it is also mentioned that actions of RAMLAB stimulate the building of mutual relationships and trust. Good and clear communication, consistency in behavior and the fulfillments of made agreements contribute to this.

Concluding, respondents are satisfied by current state of affairs and tell RAMLAB to continue like this and not to loosen the reins.

Management Strategies focused on Innovation and Knowledge

After discussing general management strategies, management of innovation and knowledge will now be discussed. In Chapter 2 the most valued strategies that deal with innovation and knowledge were discussed. Which of these strategies can be found in the RAMLAB network and which are mentioned by the respondents?

As has become clear from the foregoing, knowledge is a great asset of this network. Managing this correctly is therefore perceived to be important. What is directly associated to this, is the management of innovation appropriability. The developed, bundled knowledge of WAAM and the progress of technological developments needs to be protected from opportunistic behavior, freeriding and mostly from competition. This is done by providing a fitting institutional design and by actively excluding competing actors. The creation and signing of NDAs and IPs contribute to this, as discussed earlier, who are certainly appreciated and actually seen as a requirement by participants. It brings ease and trust by managing the appropriability of the innovation this way, and this contributes to the stability of the network. Furthermore, stability is brought by lengthening the shadow of the future (visualizing the maturity of WAAM) and by building multiplexity; this is strengthened by technological road mapping. Technological road mapping includes providing clarity of the innovative processes and setting future objectives and the support for making strategic choices. RAMLAB is seen as decision-maker and driver behind the innovative process. Also providing the necessary resources for R&D is mentioned as a appreciated management strategy. RAMLAB facilitates R&D among others, by providing a location, researchers and test facilities, bundling of knowledge and further deepening this and so on. However, RAMLAB facilitates it, but with the substantial help from the members because of their interdependencies. RAMLAB does not have enough resources on its own to facilitate everything, therefore the pooling of resources is required. Furthermore, management of knowledge mobility is seen as an important strategy of innovation and knowledge. By this the distribution and division of knowledge is meant. This dissemination of knowledge largely takes place at meetings, where presentations show how the network is doing and what progress is made. Additionally, this also takes place with one-to-one projects, or during conversations where mutual questions are asked. The knowledge acquired remains central to RAMLAB and they bundle this and also know through their overview of the network who they should reach if they have questions about specific topics. This way of knowledge sharing is appreciated by the members, also how often this happens and the amount is seen as just right. The quote below elaborates on this:

“After the meeting you will also receive a report, digitally, and you can of course read it at home. And I think that is working well. And they also distribute the level of knowledge difficulty in such a way that it remains interesting for all members. [...] And I think by keeping it fairly general there it stays interesting for everyone. Otherwise, those meetings will be far too long and far too boring and complicated.”

(Personal communication, 26-09-2019).

Because the gained knowledge is often seen as complex, clear choices must be made about the extent to which the techniques and details are discussed. As the above quote indicates, too in-depth knowledge would become confusing for members who are not specialized in that specific part, so the right balance must be sought, and the insights of the respondents indicate that this is often found.

Network Manager

An essential skills of network managers is to bring and maintain stability in the network, in order to structure, coordinate and control. Network managers must have the skill to promote broad and active participation, ensure broad-based influence and control, facilitate productive group dynamics and extent the scope of the process. Network managers must encourage participants to having an open attitude, to stimulate creativity and synthesizing, use transformative techniques and explore potentials for mutual gains.

When asking the respondents about the management of the network they unanimous refer to Vincent Wegener as network manager, and drawn slightly wider, the RAMLAB company as network

management. He is seen as the catalyst or network, the spider that connects and keeps everyone connected.

“Vincent is the great captain of the team.”

(Personal communication, 30-09-2019).

The respondents are satisfied with him as a manager. He is seen as a network administrator and complimented on his ability to win people over for his ideas, interests and plans. In addition, he has a good overview of the network and the industry, so he is well capable of making connections, networking and binding organizations with the resources that were requested at that time to the network.

“Vincent knows very well which organization has which knowledge and whether they have something to offer in a project.”

(Personal communication, 25-09-2019).

In Chapter 2 a distinction was made between three leadership styles that emerge in complex, innovative environments: administrative, adaptive and enabling leadership. The style that most closely matches Wegener's style is the second style, adaptive leadership. This leadership style pays attention to creating and developing new solutions that respond proactively to the adaptive needs of an organization. This is endorsed by respondents that mention that he is always looking for new ways of working, stimulating innovative ideas and supporting the inclusion of diversity in skills and perspective. In addition, this style is also linked to boundary spanning activities, which means that as a manager you have to be strongly connected to the internal and external boundary of the network. This falls within his qualities, as mentioned above, he is good at making contacts, he invites people from the industry for a coffee and then looks at the possibilities for WAAM and the network.

Concluding, it can be said that the members are satisfied with the manager, management and the management strategies that are implemented in the RAMLAB network.

After analyzing all seventeen and one bonus ('people of RAMLAB') factor, a better picture of the network, its content and the experience of good collaboration are inventoried. The following paragraph looks into the formulated relations from the literature and the empirical evidence from this study.

5.2. Analysis of Good Collaboration

In paragraph §2.3, the four overarching variables were defined and set out for this study. At the same time, corresponding assumptions were presented. In this paragraph these assumptions and the previous analysis of §5.1 are compared, looking if the formulated conditions that contribute to good collaboration are also perceptible in RAMLAB.

Beginning with the starting conditions and its three sub-variables. In the literature it was stated that when incentives outweigh constraints, it is more likely that actors join the network. The analysis reveals several incentives that are mentioned by the respondents, but they also mention a number of constraints on participation. However, they feel the benefits outweigh the disadvantages, which has resulted in them deciding to join the network. Then, looking at power-resource-knowledge asymmetries. Whenever there is a big asymmetry in power-resource-knowledge balances, this can have a negative or manipulative effect on the course of collaboration. Respondents say that there is an asymmetry of inputs by organizations in the network, but that they do not experience any negative or manipulating consequences of this. And at last, when considering the prehistory of cooperation or conflicts the literature states that a positively perceived prehistory has a fostering function on cooperation and results in a higher trust level. The respondents mention that there were no conflicts between members before they joined the network from foregoing interaction. Some members knew each other beforehand, they had collaborated before or were each other's clients, but this had no negative impact, rather a positive one, since some members introduced other organizations to the network. When looking at starting conditions in general it can be concluded that all three factors were positively perceived by the respondents and in their

opinion contributed to good collaboration. However, more importance was attached to the incentives and constraints on participation than to the input asymmetries or the previous relationships.

Then, looking at the second overarching variable: the institutional design of the RAMLAB network. A well-fitting institutional design contributes to the collaboration by facilitating advantageous conditions for successful collaboration. Starting with the rules within the network. Clear ground rules result in higher procedural legitimacy and trust-building, it reassures members that the process is fair, equitable and open. Having clear ground rules therefore results in better collaboration. Rules concerning innovation most often concern intellectual property and protection of the innovation. The analysis shows that respondents have the opinion that having lots of rules in a network slows down the (innovative) process and they negatively charge formal rules. That is why they see it as an advantage that few rules have been formally laid down about the cooperation itself, however, a couple of formal agreements are found to be very important: the NDAs and the IPs. When the respondents tell about informal rules or informal design aspects, they talk about gentlemen agreements, working in a decent way, using your common sense and they indicate that they prefer an informal, open working atmosphere in which everything can be said and done, without having the feeling to act restraint. The design of the network structure has to support the aims and goals of the collaboration, in this case to advance WAAM technology and its technological applicability. In this network a triple helix design would fit best, because respondents endorse the need for academic basis, the experiences and specialisms from the industry and public actors to support and supplement the network. Chapter 4 shows that the network qualifies as triple helix network. Furthermore, the network is build-up in three layers, a network core, network partners and network members, whereby RAMLAB company fulfills the role as lead organization and hub-firm of the network. Respondents state that, in their opinion, this design and structure fits the network best and this enhances the chances of meeting their goals. The third factor, process transparency, adds to good collaboration whenever the process perceived as real and transparent. Members find transparency very important, however, they do not experience the decision-making but do not think this reduces their experience of good collaboration. They say that certain aspects need to be transparent, such as the process and outcomes and others aspects are less important in this respect. The same applies to participatory inclusiveness. The respondents state that the network is not inclusive to all, but contrary to what the literature states, it is not seen as a condition that detracts successful collaboration, but enhances it. Then, the exclusiveness of the forum enhances good collaboration since actors sooner find your network attractive. RAMLAB is experienced as an exclusive network since comparable networks are scarce. Therefore it is easier to include desired actors in your network, because alternatives are limited. When looking at the institutional design in general, especially the network design as a triple helix network and rules concerning the NDAs and IPs are emphasized to be important for good collaboration in the RAMLAB network by the respondents, even as the conscious choice to keep competition out of the network.

When looking at the importance of the collaborative process for the experience of good collaboration, six factors emerged from the literature. The first factor, pooling of resources, is found to be very important for the collaborative process of RAMLAB. Respondents indicate that knowledge and expanding the knowledge and skills about WAAM is the core activity of this network. Because of their mutual recognition of interdependencies they emphasize the importance of this exchanging process and acknowledge the usefulness of this synergy and symbiosis. The interaction process and face to face dialogue, is also experienced as a very important factor for good collaboration by the RAMLAB network. The quarterly gatherings are seen as moments in which opportunities can be created, where ideas arise, contacts are maintained, people get inspired and where the process of exchange can take place in a natural, unforced manner. It is seen as a network function with many possibilities. The third factor addresses intermediate outcomes and innovation. The literature states that the presence of this increases the attractiveness of a network and potential goals, small wins, strategic plans and conducting joint-fact finding contributes to this. The respondents endorse the importance of intermediate outcomes, showing progress and emphasizing wins is viewed as an incentive for continuing to work together. Furthermore, joint-fact finding is also seen as an important component, since this allows members to work together on the knowledge development of WAAM. There is less emphasized on the importance of strategic plans. The fourth factor examines the trust in the RAMLAB network. In governance and innovation literature the role of trust and trust-building and its importance for good collaboration is

much emphasized. This is confirmed by the respondents, who state that trust can be seen as one of the most important factors of this research. They experience trust in the network and especially emphasizing on their trust relationship with RAMLAB company. In the opinion of the members, trust is being built by having an open, honest and direct attitude towards each other. In addition, trust grows by the professional and open approach of RAMLAB and it is strengthened by building mutual contact, excluding competition and having an open and honest attitude towards each other. The fifth factor concerns commitment to the process. The more committed actors are the more successful the collaborative process, according to the literature. A high recognition of mutual interdependencies, shared ownership of the process and openness to exploring mutual gains add to this. In RAMLAB everyone is aware of their mutual (technological) interdependencies, symbiosis, synergy and complementing role on one another. This is also one of the reasons why they joined the network. Recognized mutual gains are the cross-sectoral exchange of knowledge and experiences, the joint processes, the symbiotic collaboration, network expansion, and the synergy of the learning and developing process. Respondents emphasize the importance of a joint learning process and the knowledge that results from this. Then, members did not experience a very high ownership of the process. They felt that RAMLAB company should assume this role, which is in line with the perception of the lead organization and hub perspective. However, they did experience a high level of involvement to the process, which is closely related to the responsibility of the ownership. The second-last factor of the collaborative process that adds to good collaboration, is having a shared understanding within the network and between the network members. A mission is clearly stated and recognized by the members and the importance of having a shared vision is emphasized. They also experience that they want to work jointly towards the same goals and having shared values that contribute to this are: wanting to have and creating high-quality knowledge and learning process, clear and smooth (*vlotte*) mutual communication, having an open, honest attitude towards each other and help each other (and especially RAMLAB) where possible. Ultimately, everyone has other benefits from the network, but the general lines and motivations are shared and, according to the respondents, this contributes to good collaboration. Then, the last factor of the collaborative process, concerns the people of RAMLAB. It follows from the interviews that the human resources, the people associated with the network, make a big difference in the success of RAMLAB's current collaboration. Both the attitude and mindset of the members, the 'deserve factor', the diversity of the people, their thoughts and specialism and the professionalism all contribute to good collaboration. When looking at the collaborative process in general, especially the (open, honest and direct) interaction process and face to face dialogue, trust and trust building, the people of RAMLAB and the pooling of resources and knowledge are considered to be the most important factors for good collaboration. Although the other factors are also seen as important contributions to good collaboration.

At last, the network management is discussed. The literature states that the better the network is management the more this enhances the performance and success of the collaboration. In an innovative network, this concerns specifically strategies targeting knowledge and innovation. Respondents are in general very satisfied with how the network is managed. Especially how the management motivates and activates the members, how they keep the network together and how knowledge and innovation are managed. Also the choices for design, creating opportunities, dissemination of knowledge and short lines of contact are often mentioned management strategies that contribute to good collaboration. When focusing on the network manager, the literature states that a well-fitting leadership styles adds to network performance and success. From the analysis follows that Wegener most closely matches the adaptive leadership style. It appears that this style often occurs in changing environments, which fits within an R&D or innovative network. Which creates room to judge that this is an appropriate style. In general the respondents were very content with how the network was managed.

5.3. Most Important Factors of Good Collaboration

In this section the most important factors of good collaboration are outlined. All interviewees were asked what they see as the ideal collaboration for the RAMLAB network. At first the question '*To what extent is good collaboration experienced in this case?*' is answered, followed by '*Which of these factors contribute the most to the explanation of the degree of (good) collaboration in this case?*'.

It can be said that all respondents are satisfied with the current way of working together. They see the cooperation within RAMLAB as a good way of collaboration within a network in an innovative context. They answer that if they were not satisfied, they would not remain or would not be in this network anyway. This because they are not (legally) tied, and participation is not mandatory, and participate on their own initiative. Mentioned reasons what would decrease their satisfaction would be if there was no mutual trust, if competing actors would be involved in the network, if the network stopped making progress, if they could not contribute to the network themselves, if WAAM becomes fully developed or if they see no future anymore in WAAM technology.

An overview of most important factors of good collaboration is made to answer the second question of this paragraph. In Table 2 an overview is made of the analysis of the most important factors of good collaboration. A Likert-scale is used to rate the value the respondents gave to the factors (as follows: not an important factor --- / -- / - / +/- / + / ++ / +++ very important factor for collaboration), which has been an interpretative process. Based on this a top 5 of most important factors emerged:

- [1] Inter-organizational learning and pooling of resources and knowledge;
- [2] Importance of interaction process and face-to-face contact;
- [3] Incentives and constraints on participation;
- [4] People of RAMLAB;
- [5] Network management.

| Factors | Interview 1 | Interview 2 | Interview 3 | Interview 4 | Interview 5 | Interview 6 | Interview 7 | Interview 8 | Interview 9 | Interview 10 | Total |
|---------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------------|
| Starting conditions | | | | | | | | | | | |
| Incentives/constraints | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | | | + = 24 - = 0 |
| P-R-K asymmetries | +/- | - | | - | - | + | | - | | | + = 1,5 - = 4,5 |
| Prehistory of cooperation/conflict | + | - | | - | - | | | | | | + = 1 - = 3 |
| Institutional design | | | | | | | | | | | |
| Rules within the network | - | - | - | - | + | | | | | | + = 1 - = 4 |
| Network structure | ++ | + | +++ | +++ | +++ | ++ | | ++ | | | + = 16 - = 0 |
| Process transparency | | | + | | + | + | + | | | | + = 4 - = 0 |
| Participatory inclusiveness | -- | | - | | | | | -- | | | + = 0 - = 5 |
| Forum exclusiveness | | | | | | + | + | | | | + = 2 - = 0 |
| Collaborative process | | | | | | | | | | | |
| Resource and knowledge exchange | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | + = 30 - = 0 |
| Face-to-face dialogue and interaction | +++ | +++ | +++ | | +++ | +++ | +++ | +++ | +++ | +++ | + = 27 - = 0 |
| Intermediate outcomes and innov. | | | + | | + | + | ++ | | | | + = 5 - = 0 |
| Trust and trust-building | | +++ | +++ | ++ | ++ | +++ | | ++ | | ++ | + = 17 - = 0 |
| Commitment to the process | | | +++ | | + | | | +++ | | | + = 7 - = 0 |
| Shared understanding | + | | ++ | + | + | ++ | | +++ | +++ | | + = 13 - = 0 |
| People of RAMLAB | +++ | +++ | +++ | ++ | +++ | +++ | | +++ | | +++ | + = 23 - = 0 |
| Network management | | | | | | | | | | | |

| | | | | | | | | | |
|---------------------------------|-----|-----|-----|----|-----|-----|-----|-----|-----------------|
| General management strategies | +++ | +++ | +++ | ++ | +++ | +++ | +++ | ++ | + = 22 - = 0 |
| Innovation/knowledge management | +++ | +++ | +++ | ++ | +++ | +++ | +++ | ++ | + = 22 - = 0 |
| Network manager | | +++ | | | +++ | +++ | +++ | +++ | + = 17 - = 0 |

Table 2. Most important factors for collaboration.

The above mentioned variables have already been discussed in the previous section (§5.1 and §5.2), whereas the previous sections dealt more in substance with the presence and content of these factors, here it will briefly be discussed why they see these five factors specifically as the most important factors. Beginning with the most frequently cited factor (30+s), resource and knowledge exchange and inter-organizational learning. Respondents frequently emphasize that they understand the importance of exchanging resources and knowledge in order to move forward. They are aware of the complexities associated with WAAM, the developments and their practical implementation. Their interdependency makes them eager to cooperate, provide feedback and contribute to the development of WAAM, because they know that it is almost impossible to do otherwise. Therefore it is a big and important factor for them to collaborate, and important for the collaboration of the RAMLAB network. They see the learning process not only as a win for the development of WAAM, but see this also as a gain for themselves or their own organization as well, which makes the collaboration even more attractive.

Then, the factor with the next highest score is face-to-face dialogue and having a well-functioning interaction process (27+s). The respondents emphasize their preference for a smoothly functioning interaction process, since this enhances the developments of WAAM and inter-organizational learning, which is seen as their mutual goal. When having face-to-face interaction, possibilities and opportunities arise from seeing each other in real life and are essential in the eyes of the respondents for good collaboration. But also having a well-functioning communication process, in which people respond quickly, help each other, are open to the exploring of mutual gains and demonstrate their shared vision. It also influences their trust relations, their input and commitment and a relaxation of manners. Respondents state that by having face-to-face interaction that they understand each other faster and better, they find solutions more easily and miscommunication is increasingly prevented. In addition, almost all respondents indicate that they favor open, honest, transparent and informal communication and that this enhances mutual trust and that it builds trust-relations. For these reasons, this way of communicating is seen by them as an important factor for good collaboration.

Then, the third factor, incentives and constraints on participation (especially incentives), received 24+s. As emerged from the analysis of §5.1, there are many reasons why respondents wanted to participate in the RAMLAB network. Members like to make use of this arena, so they can stay up to date with the technology, it is cheaper than doing this by yourself and they are, thanks to the high-quality knowledge and highly valued experiences of the other members, confident that this is the right way to further advance the innovative WAAM. Further, it is emphasized that there must be something to be gained for both parties. Those reasons emerge as a great motivator to stay in the network and to contribute to a good and successful cooperation process.

The fourth factor concerns the people of RAMLAB. This factor was not created for nothing, it was often mentioned that the people of RAMLAB company and network truly make the difference and contribute to good collaboration. Both their mentality, expressed in enthusiasm, persistence and a collaborative mindset, contribute to this, as well as the 'deserve factor' (*gunfactor*) which often emerges from the interviews. Actually wanting to help each other, and not always wanting something in return, is a characteristic that the members like to see in a collaboration. Also the *Rotterdamse*-mentality, being fair, honest, direct and not feeling restrained in saying what you want and sometimes saying what you must say (even if it is not socially desirable). Finally, the professionalism of RAMLAB company is mentioned, and the related confidence in RAMLAB, which both contribute to their perception of good collaboration.

And at last, network management. It is endorsed that network management is important to the respondents, both general management strategies as management strategies concerning innovation and knowledge. Respondents say that without network management RAMLAB would not exist, which shows the importance of this factor. Management brings and keeps the members together and is the

spider that ensures that the different threads of the web stay connected. Several strategies lead to the importance of management, but two managerial decisions stand out: namely the choice of the institutional design to exclude competition in the network and the location of RAMLAB. Actively excluding competition is cited several times to be of extreme importance for the degree of sharing information, resources and knowledge. Several respondents say that they may leave the network or at least be less actively involved in the network whenever competitors would join. The aesthetics of the scenery are cited several times, it is found to be motivating, stimulating and inspirational. Also the geographical location, affiliated organizations are located nearby and see this as an advantage that they can quickly drop by, and be able to solve problems face-to-face together or pass by with customers to show this innovative site. The management of knowledge mobility and knowledge appropriability are seen as most important innovation and knowledge strategies.

What is also striking about the overview of the analysis is that there are four factors that received a negative assessment from a number of respondents. This does not mean that these factors have a negative contribution to good collaboration, but that they think it is not important (or less important than the other factors) for good collaboration. This concerns the following variables: power-resource-knowledge asymmetries (4,5-s), prehistory of cooperation(3-s), rules within the network (4-s) and participatory inclusiveness (5-s). Two out of three starting conditions are valued as not or less important factors for good collaboration by a number of respondents. They mainly indicate that there should not be too much value attached to previous relationships, that the future should not be influenced too much by this and that one should look at it with a rational, businesslike attitude. The factor rules within the network is a special factor, since it is most often mentioned that the members experience little rules and do not like a stiff network with many rules. They prefer little rules and an informal sphere. Therefore they mention that rules do not specifically contribute to good collaboration, also because most people are very motivated by themselves, they are not forced to participate and it is said that participants use their common sense and experiences in the current collaboration. However, they see the NDAs and IPs as important legal formalities, which, in this case, is an exception to the rule. And at last, also participatory inclusiveness is seen as a factor that is not too important for good collaboration. Especially since some respondents state that actively excluding actors promotes the good collaboration in the network.

When answering the last sub-question, *'Which of these factors contribute the most to the explanation of the degree of (good) collaboration in this case?'*, this answer would be: inter-organizational learning and pooling of resources and knowledge, the interaction process and face-to-face contact, incentives on participation as motivation, the people of RAMLAB, network management.

CHAPTER 6: CONCLUSION AND DISCUSSION

This chapter begins with the conclusion of this research, and thereafter a discussion where is reflected on the research and recommendations for follow-up research and practical recommendations for RAMLAB are briefly made.

6.1. Conclusion

The aim of this thesis was to answer the following research question: ‘Which factors influence the experience of good collaboration of a network situated in an innovative context, and which of these factors can be seen as most influential?’. Thereby five sub-questions were formulated to arrive at an answer step by step.

Starting with the first sub-question: ‘What does the theory say about good collaboration and which factors are seen as important?’. By means of a literature study Chapter 2 attempts to answer this question by combining governance and innovation literature. The concepts of public administration, governance and governance networks are discussed. Governance networks are networks of interdependent actors, who exchange resources and try to influence, steer and use strategies, which cluster around problems, programmes or sets of resources, who emerge, are sustained and changed through interaction. They are increasingly desired, because of raising complexities and wicked problems, which acquire more knowledge and specialism. Collaboration and exchange of resources is therefore necessary, which increases interdependencies and for that reason again stimulates the demand for cooperation between organizations. The well-known model of Ansell & Gash (2007) is used as foundation for conceptualizing good collaboration. It describes factors that contribute to good collaboration. From their theory four overarching factors emerged: starting conditions, institutional design, collaborative process and network management. According to the literature, a positive presence of these factors and a good substantive content thereof will lead to better collaboration within a network. These factors have been supplemented with insights from other (governance) authors to provide a more substantiated theoretical basis.

Thereafter, we became familiar with innovation, innovation networks and its characteristics. Innovation networks are networks where patterns of interaction between heterogeneous actors result in desired outcomes of achieving innovation through mutual learning, synergy and exchange of resources. They operate often in a context with high levels of complexity, uncertainty and risks. This, in combination with high interdependencies and high demands for expertise and knowledge, leads to an increasing demand for inter-organizational collaboration. The proper functioning of the collaboration is often related to a high level of innovative performance. Factors that add to good collaboration are active participation, efficient interaction, having a shared vision, common ground and relation-, consensus- and trust-building. Certain network management techniques contribute to good collaboration in an innovative context as well, specifically guiding and facilitating interaction- and collaboration processes, providing R&D services and techniques focused on knowledge and innovation.

The above has been merged into the four overarching factors of Ansell & Gash (2007) and resulted in 17 sub-factors. For an overview, see Table 3:

| Important factors of good collaboration | | |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Starting conditions | <ul style="list-style-type: none"> • Incentives (and constraints) on participation • Power-resource-knowledge symmetries | <ul style="list-style-type: none"> • A positive prehistory of cooperation and conflict |
| Institutional design | <ul style="list-style-type: none"> • Rules within the network • Network structure • Process transparency | <ul style="list-style-type: none"> • Participatory inclusiveness • Forum exclusiveness |
| Collaborative process | <ul style="list-style-type: none"> • Resource and knowledge exchange • Face-to-face dialogue and the interaction process • Intermediate outcomes and innovation | <ul style="list-style-type: none"> • Trust and trust-building • Commitment to the process • Shared understanding |

| | | |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| Network management | <ul style="list-style-type: none"> • General management strategies • Management strategies focussed on innovation and knowledge | <ul style="list-style-type: none"> • Network manager |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|

Table 3. Following from theory: The important factors of good collaboration.

The second sub-question (*‘What does the network of this case study look like?’*) is answered in the empirical chapter, Chapter 4. Here the context in which the network operates and a stakeholder- and network analysis were presented. The chapter shows that RAMLAB is both a company and a network. RAMLAB’s aim is to make WAAM technology usable and working towards a future where metal parts can be printed on demand. Because of its technological complexities and high level of knowledge, collaboration is a prerequisite for developing WAAM. This led to the initiation of the network, where exchange of resources, in-depth knowledge and experiences inter-organizational learning stand central to advance WAAM. Currently the network consists of 26 organizations, with diverse and divergent specialisms centered around 3D-printing in the maritime sector. The network has achieved quite a lot in a short period of time, and in 2017 world’s first certified 3D-printed propeller is manufactured, followed by a 3D-printed crane hook in 2018. These key events are driven by the exchange of knowledge, experience and resources of RAMLAB and its network members. Now, projects continue, as well as the development of WAAM technology, certification processes and case- and feasibility studies. A theoretical analysis showed that the network can be qualified both as an governance network and as innovation network, more specifically as a triple helix network.

The third, fourth and fifth sub-questions were answered in Chapter 5; the analysis of the independent variable, the factors of good collaboration, based on the conducted interviews.

Starting with the third sub-question: *‘To what extent is good collaboration experienced in this case?’*. This question can be answered very succinctly, namely members are generally very satisfied with the current state of affairs. And so they say, whenever this changes or whenever they see no need for it anymore, they can always exit the collaboration and network.

Followed by the fourth question: *‘To what extent are factors that, according to the theory, influence collaboration, present in the case?’*. Generally speaking, you see that sixteen factors are present in the network, and two factors are absent (process transparency and participatory inclusiveness). The eighteen factors will be discussed below, based on the four overarching variables, so that it becomes clear to what extent these factors are present.

Beginning with the first variable, starting conditions. When it comes to incentives and constraints on participation, members mainly talk about incentives for their joining the network. The available knowledge and the professional development of this knowledge on WAAM is seen as a big motivator. In addition, reducing the gap between the academical sector and the industry by focusing on applicability, the relatively inexpensive way to be involved and up to date of WAAM technology, their recognition of interdependency and need for pooling of their resources, the network function of RAMLAB and the motivation to ‘not miss the boat’ (missing out on this technology) and missing future business opportunities are other frequently mentioned incentives to join the RAMLAB network. However, constraints on participation are also mentioned, although this can be seen more as a ‘if this would be this way, then I would refrain from participating’. Restrictions on joining are a shortage of resources, a non-sufficient protection of intellectual property and sensitive information, having competition in the network and whenever participants feel they can no longer contribute or whenever the technology of WAAM is mature. When looking at the second factor, power-resource-knowledge symmetries, you see differences in the input of members, so to say, there are power-resource-knowledge asymmetries. However, this is not experienced as something negative by the respondents. The rational attitude prevails that the more you invest, the more you will get back; and it must also be possible and fit within the capabilities of your organization. And then, the third factor of starting conditions is the prehistory of cooperation and conflict. Previous conflicts was not experienced, however, previous collaboration was. This factor was considered less important, people were mainly interested in whether or not there was competition among the members.

Then, the second variable concerns the institutional design of the RAMLAB network. It is generally experienced that there are few rules within the network. The NDAs and IPs are considered to be most important. Openness, common sense and honesty are informal rules they work by and in which they like to collaborate. The network is structured in three layers: RAMLAB company (the core), the partners (highly involved) and the members. The RAMLAB company is seen as spider in the web, and the coupler and binder of the network. As Chapter 4 showed, the RAMLAB network can be classified as a triple helix network and follows its design. When looking at the transparency of the process, on one hand members experience process transparency, which is encouraged by for instance the network meetings and sharing the progress and outcomes. On the other hand, this is not the case. The decision-making lies entirely by the RAMLAB company and members have no formal say in this. Then, the fourth factor concerns participatory inclusiveness. RAMLAB is not the most inclusive network, they are actively excluding certain actors, so that competition can remain excluded from the network, further, the required degree of resources excludes certain organizations, especially smaller organizations may experience this. And the fifth factor, forum exclusiveness. RAMLAB can be seen as an exclusive forum since there are very limited alternatives, and these alternatives have different levels of quality and different focal points and therefore making them less attractive than RAMLAB.

The third variable of this thesis concerns the collaborative process. When looking at the six sub-variables, the six factors, you see that all of them are present in this network. In the RAMLAB network the exchange of resources, knowledge and inter-organizational learning does take place. Knowledge is seen as the most important asset of this network and the pooling of resources and knowledge is seen as a necessity to make innovative progress. Most interaction takes place in the quarterly meetings, by phone or e-mail and one-to-one meetings. Respondents see benefits in face-to-face meetings, since it enhances resource exchange, it creates networking moments and it offers room to discover new possibilities and ideas. When looking at intermediate outcomes and innovation, the 3D-printing of the WAAMPeller and the crane hook are often mentioned, just as advancing of the WAAM technology. Intermediate outcomes contribute to good collaboration by motivating people to participate, gaining publicity and a growing confidence in the abilities of RAMLAB. Providing strategic plans as a network was less discussed in the interviews, but joint-fact finding was considered to be very important, and seen as a core activity of the network: jointly enhancing WAAM technology and finding practical applicability. Then, looking at trust and trust-building. Mutual trust is found to be vital for the collaborative process, a certain trust level has the effect that members dare to be open and transparent, share their resources and knowledge and are open to working together. The exclusion of competition, NDAs and IPs contribute to this because it is an additional in-built security. However, a side note must be made, trust is viewed to be very important, but when considering trust in the network, it concerns especially members' relationship with RAMLAB company. Trust is built by an interaction process that is based on being honest, direct and open and an informal atmosphere to work in. The fifth factor was commitment to the process, which also looks at mutual recognition of interdependence, shared ownership of the process and exploring mutual gains. Members are very aware of their interdependencies, it is one of the reasons why the network was established and why people participate in it. Most frequently mentioned mutual gains were inter-organizational learning, symbiotic collaboration, network expansion and synergy of the learning and developing process. However, the sense of a shared ownership of the process is less present. Members want to contribute and help, but see RAMLAB company as ultimately responsible and therefore owners of the process. There is a feeling of having a shared understanding, members want to work jointly towards the same missions and goals, they share the same values and problem definitions. It follows from the interviews that members (often partners) that are more involved also have a more profound feeling of having this shared understanding. And at last, when examining the collaborative process of RAMLAB, the people of RAMLAB are found to be important. Their attitude plays a big role in this; being open, transparent and proactive, good communication and having the award factor (*gunfactor*) are characteristics that are being appreciated.

The last variable of this analysis is network management. First there was looked at general management strategies, then at strategies focused on innovation and knowledge and finally at the network manager. Network management was found to be very important by the respondents. An often heard expression was that the network would fall apart without the management. Many strategies mentioned in the literature were also stated by the respondents. Special attention was paid to publicity

seeking and the chosen location of RAMLAB, which was praised for two reasons: the geographical location and the aesthetics of the place itself. When considering innovation and knowledge management, again many similarities are found between the management strategies in the literature and RAMLAB. Especially knowledge mobility and knowledge appropriation were seen as important strategies, since these protect the gained insights and mutual distribution. When looking at the network manager, Vincent Wegener and RAMLAB company are designated as managers of RAMLAB. The network management is seen as catalyst of the network and an adaptive leadership style can be assigned to Wegener.

And, the last sub-question: *‘Which of these factors contribute the most to the explanation of the degree of good collaboration in this case?’*. After first analyzing all the variables in §5.1, the analysis of section §5.2 examined which factor respondents considered to be the most important factor for good cooperation. This resulted in an enumeration of five factors:

- [1] Inter-organizational learning and pooling of resources and knowledge;
- [2] Importance of interaction process and face-to-face contact;
- [3] Incentives and constraints on participation;
- [4] People of RAMLAB;
- [5] Network management.

And that leaves one final question to be answered, the main question of this research: *‘Which factors influence the experience of good collaboration of a network situated in an innovative context, and which of these factors can be seen as most influential?’*. As discussed in the previous answers, you see that of the 17 factors that emerged from the literature study, 15 are present in the network. The other two factors (process transparency and participatory inclusiveness) cannot be examined present, since it does not correspond to the operationalization of Chapter 3. However, the absence of these factors is not seen as something negative, but as conscious choices (in the institutional design) and does not alter the experience of good collaboration. In general, respondents are very satisfied with the current state of collaboration in the RAMLAB network. The following five factors emerge as most important: inter-organizational learning and pooling of resources and knowledge, the interaction process and face-to-face contact, incentives on participation as motivation, the people of RAMLAB, network management.

6.2. Discussion

This section briefly reflects on the results of the research and the research itself, where at the same time recommendations are made for follow-up research. Followed by a reflection of the relevance of this research, discussing the theoretical and practical relevance of this research, supplemented by recommendations for RAMLAB. In Chapter 3 limitations, validity, reliability and objectivity of this research are already mentioned, this chapter complements this.

Beginning with a discussion of the results of the research. What remarkable is about this research is that the respondents are very positive about the current collaboration of the network. Little negative aspects are indicated and when asked in the interviews, they said they had not (yet) experienced them. They say that almost all variables are present in a network, that this contributes positively to the collaborative process and that it contributes to good collaboration. They therefore paint a very positive picture of their network participation. Furthermore, the answer they formulate to the question what they would do if they were dissatisfied with the collaboration explains this comment: they would leave the network. This implies that the chances of speaking to participants who are not content with RAMLAB's current collaboration format are very little, because they have probably left the network already. This has resulted in a (selection) bias and therefore influenced the results of this research.

Another point worth mentioning is that both governance and innovation literature state several times that it is important to reach consensus in a network. This is mentioned in both the collaborative process as well as in network management. When asking about the presence of consensus or the value of consensus in the RAMLAB network, you see that members do not actually seek consensus in decision-making. They think it is fine that RAMLAB determines the course of actions and takes decisions. The results deviate from the literature on this area. On the other hand, there is consensus on

mission and vision of RAMLAB, members all agree in that and emphasize the importance of this for collaboration. Therefore is the goal of reaching consensus being met in that area.

A final striking point is the fact that the absence of the two variables would theoretically mean that this would decrease the extent of good collaboration. Chapter 2 clearly showed that a network should be as inclusive as possible with regard to participatory inclusiveness, and that process transparency should also be as high as possible for good collaboration. However, the interviews show that the network does not act completely transparent, for example, decision-making is not kept publicly and there are no formal procedures in which the members have a say in the state of affairs. This while the analysis shows that transparency is very important to the respondents. How is it that they don't value process transparency that high? The answer of the respondents is that they wonder if it is necessary to know everything, and thereby imply that their answer is: no it is not necessary to know everything about everything. Some choices just have to be made, and they do not want to put the time and effort into all these decisions. RAMLAB is the right actor to execute this, and as long as it does not deviate too much from the goal they have in mind, they feel that they should not be bothered with it. They find transparency important when it concerns interaction, results and the developments of WAAM, but find it less important for the extent of good collaboration if certain information is not shared or decision-making is behind closed doors. When elaborating on participatory inclusiveness you see a similar line of reasoning. The literature states that a network should be as inclusive as possible and that actively excluding actors has negative effects on good collaboration. The respondents actually say the opposite. The active exclusion of certain actors is seen as a security and as a good network management strategy. You see that respondents find it more important to have a more closed network, that competition is kept out and that they can (to some extent) share sensitive information, act openly and transparently, than that they see network inclusiveness as an actual contributing factor for good collaboration.

When reflecting on the research itself, some difficulties which have emerged in the execution of the research can be considered. Beginning with the fact that the quantity of seventeen variables can be considered as much. While conducting the interviews as well as analyzing the variables, you noticed that a lot had to be treated in the limited space of a master thesis. As a result, some topics were discussed in a more superficial way and there was less room to dive deeper into everything (because much had to be discussed in an hour). For follow-up research it is therefore recommended to consider less factors at the same time, so that it is possible to better consider the content of these variables in both the interviews and the analysis. Therefore it could be decided to divide the research into four parts, so that one study can look at one of the four overarching concepts (starting conditions, institutional design, collaborative process or network management). In addition, these four studies could be carried out on multiple networks, so that you can merge the results by means of a meta-analysis and then possible statements can be made about the degree of good collaboration as a whole.

This is also in line with the next point of reflection. It should be noted that this is only a case study, which only provides results from one specific network. It may be interesting to conduct the same research with more networks in an innovative context, and subsequently conduct a comparative study of several cases. That way it is possible to be able to make more generalizing statements about the research, which is currently not possible since you cannot generalize from one case study.

In addition, another barrier that has been encountered is that the network deals with a complex subject in terms of content. During the interviews, respondents often discussed WAAM, 3D-printing or a specific part in which they are specialized. The WAAM technology is quite complex and difficult to understand; during the interviews a lot of time was spent to explaining these topics and processes to me. This was necessary to understand the content and context of the network and to understand the necessity of the pooling of resources and inter-organizational learning, but it also took valuable interview time, while a relatively high quantity of variables had to be discussed in the time of one hour. It is therefore recommended to be informed about the topic of the network, that during the interviews the variables can really be discussed.

Another difficulty arose from the question which factors the respondents considered most important. The answer to this question largely ran through the entire interview and was formulated more in an ongoing story. This makes it more difficult to actually distinguish what is really most important to them, and this is largely an interpretative process, in which the researcher had to interpret the trade-offs.

Therefore the following is recommended for follow-up research: the research is strengthened if respondents actually have to fill in a top 5 with variables that they consider most important for good collaboration. It is advisable to make rankings, in order to guarantee objectivity in this part of the analysis.

And a final point, this concerns the difficulty in distinguishing between the independent and dependent variables. The dependent variable can quickly be seen as the interpretation of the dependent variable, which results in circular reasoning. This was also difficult with analyzing and the processing of the results. The line between them was not clear in the whole processes. It is therefore recommended to make this distinction explicit from the start and to include this in the methods.

Followed by a reflection of the relevance of this research. Beginning with theoretical relevance of this research. In Chapter 1 the research objective was formulated of examining the RAMLAB network by combining governance and innovation literature. Chapter 2 looked at relevant literature related to network collaboration and what enhances good collaboration. In terms of content, this research has examined the concepts of both approaches, its interpretation and the relevant factors of good collaboration. The conceptual framework in §2.3 came forth from this, where the relevant information from both governance and innovation networks comes together. This has led to wider view and a broader research base. It is noteworthy that many similarities can be found in these two approaches concerning network collaboration, but that innovation literature in particular emphasizes more on the role of knowledge, the necessity of the pooling of resources and interdependencies.

The practical relevance of this research consists of insights and recommendations for the RAMLAB network and network collaboration in general. Beginning with insights for RAMLAB. You could say that members of the RAMLAB network are content with their participation. They see the current form of cooperation as a successful form of collaboration and indicate that they actually want to keep it the way as it currently is. According to them, the current way of working together matches the current status of WAAM's developments. For now, there is a high degree of satisfaction, however, over time it has to be examined whether this way of collaboration still suits and matches the next steps of the process.

A next point to consider is expanding the network or not. Contradictory statements were made in the interviews. On the one hand, it is argued for expanding the network. For example, if more organizations would be added, they could all bring their specialism, knowledge and resources, further, they could submit more case studies that would allow the technology to develop further. This way it is seen as an advantage. On the other hand it is argued that the network should not be further expanded. It is said that if too many organizations are involved in the process, people are less likely to be open and to share their knowledge and resources; also due to the increased chance of competing companies within the network. It would impede collaboration and limit the informal atmosphere. It is therefore recommended to give it some thought, make it negotiable within the network and weigh the pros and cons. A next recommendation resulting from the interviews is creating an online platform. A respondent suggested that they would see an advantage in a database for the network. It could store presentations, current projects, news updates and outcomes and easily searched by the members. This would provide an overview of the shared information, information could be looked up more easy and it facilitates and gives structure to information sharing. It can also contribute to inter-organizational learning by making information more accessible. A last recommendation for RAMLAB is a point of improvement for communication. People are satisfied with the way of communicating in the network, but the communication facilities can be improved and become more professional. It is mentioned that there are currently many different WhatsApp groups, different circulating emails and several phone calls; which is chaotic. A proposal was made to create an online communication platform where this is arranged in a structured way. This could contribute to the quality of the network, a more pleasant communication process, facilitates resource and knowledge exchange and save precious time. It would ease the process of finding the right people for the right question. Now it is indicated that searching for the right person sometimes takes a lot of time and effort. It is possible to implement the last two recommendations simultaneously, where both an online communication and data platform can be created as one.

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APPENDIX

APPENDIX I: Planning of Interviews

| | Name | Organisation | Function | Date | Interview method |
|----|---------------------|----------------------------|-------------------------------------------|-------------|-------------------------|
| 1 | Natalya Rijk | Smart-Port | Project Developer and Manager | 05-03-2019 | Orienting interview |
| 2 | Vincent Wegener | RAMLAB | Co-founder and Managing Director | 11-03-2019 | Orienting interview |
| 3 | RAMLAB | Network | Network meeting | 29-03-2019 | Orienting meeting |
| 4 | Vincent Wegener | RAMLAB | Co-founder and Managing Director | 06-05-2019 | In-depth interview |
| 5 | Peter Haspels | Valk Welding | Sales Manager NL | 20-09-2019 | In-depth interview |
| 6 | Viktoria Savran | M2i | Program Manager | 23-09-2019 | In-depth interview |
| 7 | Timo Kreule | Damen Shipyards Group | Research Engineer | 25-09-2019 | In-depth interview |
| 8 | Cees Wieringa | Valk Welding | Sales Manager Robotics | 26-09-2019 | In-depth interview |
| 9 | Johan Cobben | Voestalpine Bohler Welding | Application Engineer | 30-09-2019 | In-depth interview |
| 10 | Marko Bosman | Fokker | Chief Technologist Additive Manufacturing | 08-10-2019 | In-depth interview |
| 11 | Kelvin Hamilton | Autodesk | Technical Consultant | 18-10-2019 | In-depth interview |
| 12 | Benedetto di Castri | RAMLAB | WAAM Engineer | 01-11-2019 | In-depth interview |
| 13 | Matthijs Visser | RAMLAB | Software and Mechanical Engineer | 01-11-2019 | In-depth interview |

APPENDIX II: Overview Codes ATLAS.TI

| | |
|---------------------------------|-------------------------------------------------------------------------------|
| ◇ ● | Collaborative process |
| ◇ ● | Collaborative process_Commitment to the process |
| ◇ ● | Collaborative process_Face-to-face dialogue / interaction process |
| ◇ ● | Collaborative process_Intermediate outcomes and innovation |
| ◇ ● | Collaborative process_Resource and knowledge exchange |
| ◇ ● | Collaborative process_Shared understanding |
| ◇ ● | Collaborative process_Trust and trust-building |
| ◇ ● | Context_Context variable |
| ◇ ● | Context_Network analyse |
| ◇ ● | Context_Stakeholder analyse |
| ◇ ● | Factors of Good collaboration_Independent variable |
| ◇ ● | Good collaboration_Dependent variable |
| ◇ ● | Institutional design |
| ◇ ● | Institutional design_Forum exclusiveness |
| ◇ ● | Institutional design_Network structure |
| ◇ ● | Institutional design_Participatory inclusiveness |
| ◇ ● | Institutional design_Process transparency |
| ◇ ● | Institutional design_Rules within the network |
| ◇ ● | Network management |
| ◇ ● | Network management_General management strategies |
| ◇ ● | Network management_Management strategies focussed on innovation and knowledge |
| ◇ ● | Network management_Network manager |
| ◇ ● | Starting conditions |
| ◇ ● | Starting conditions_Incentives and constraints on participation |
| ◇ ● | Starting conditions_Power-resource-knowledge asymmetries |
| ◇ ● | Starting conditions_Prehistory of cooperation and conflict |
| Result: 26 of 26 Code(s) | |

Figure 8. Codes of ATLAS.ti

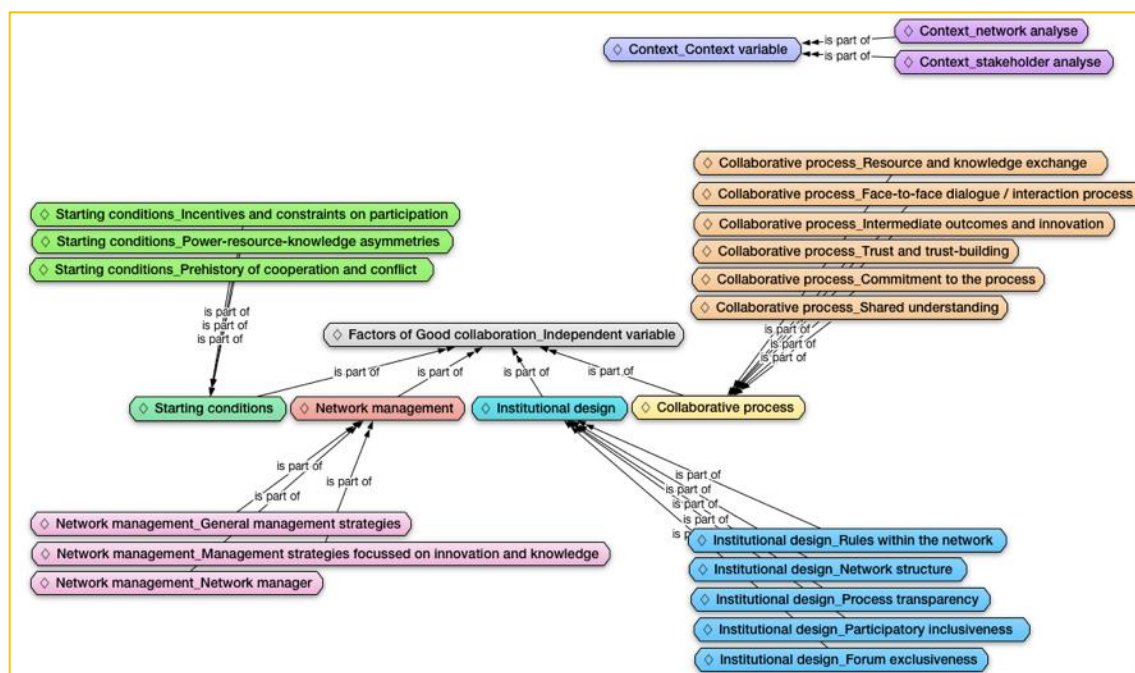


Figure 9. Relation manager ATLAS.ti

APPENDIX III: Overview of RAMLAB Network

| | Name of the organisation | Specialization of organisation for RAMLAB network | Public / private sector | Initiator / partner / member | For more information, see: |
|----|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------------|
| 1 | RDM Makerspace | Operational and facilitating partner in RDM. | Private sector | Initiator | rdmmakerspace.nl |
| 2 | Innovation Quarter | Regional development organisation of South Holland; Finances, assisting and supporting collaboration in innovation | Public sector | Initiator | innovationquarter.nl |
| 3 | Port of Rotterdam | Financer and manages, operates and develops the Rotterdam port and industrial area | Public sector | Initiator | portofrotterdam.com |
| 4 | Autodesk | Software and technology creating company; provides RAMLAB with software to weld AM parts | Private sector | Partner | autodesk.nl |
| 5 | IBM | A technology and innovation company; provides RAMLAB with analytics and IoT services | Private sector | Partner | ibm.com |
| 6 | Lincoln Electric | A company in design, development and production of welding and robot equipment; provides RAMLAB with various welding alloys | Private sector | Partner | lincolnelectric.com |
| 7 | Valk Welding | Valk Welding supplies automation for welding production, including welding robots, machines and welding consumables; provided RAMLAB with two Wire Arc Additive Manufacturing systems | Private sector | Partner | valkwelding.com |
| 8 | Lemtech (Lucht en Milieu techniek) | Company that offers air filtration services and products; it provides RAMLAB with state of the art air filtration systems | Private sector | Partner | lemtech.nl |
| 9 | University of Twente | Technical university, provides academical resources | Public sector (semi) | Academic partner | utwente.nl |
| 10 | TU Delft | Technical university, provides academical resources | Public sector (semi) | Academic partner | tudelft.nl |
| 11 | M2i | Materials innovation institute; network organisation; connecting link between industrial and academic partners | Non-profit, before public | Member | m2i.nl |
| 12 | Damen Shipyards | Operates several shipyards and service hubs, supplier of vessels and repairing ships/yards | Private sector | Member | www.damen.com |
| 13 | Royal Netherlands Navy | Service of the Netherlands armed forces; ensuring security in and from the sea | Public sector | Member | www.english.defensie.nl/organisation/navy |
| 14 | Fokker Technologies | GKN Aerospace; Global Aerospace Service Provider | Private sector | Member | https://www.fokker-services.com |
| 15 | Shell | Royal-Dutch Shell; oil and gas company | Private sector | Member | www.shell.com |
| 16 | Huisman Equipment | Design and manufacturing of heavy construction equipment connected to oil and gas, renewables and leisure markets | Private sector | Member | huismanequipment.com |
| 17 | Air Products | Company that delivers a unique range of atmospheric gases and process gases, equipment and service | Private sector | Member | airproducts.nl |

| | | | | | |
|--------|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|--------|----------------------------------------------------------------------|
| 1 8 | The Linde Group | Supplier of industrial gases, dry ice food grade gases, refrigerants and HiQ gases | Private sector | Member | linde-gas.nl |
| 1 9 | Voestalpine | A technology company combining processing and materials expertise. Focus on product and system solutions made of steel and other metals | Private sector | Member | voestalpine.com |
| 2 0 | VandeGrijp | Pipes and parts; specialized in the production of steel tubes, piles and tubular constructions | Private sector | Member | vandegrijp.com |
| 2 1 | Element Materials | An independent provider of testing, inspection and certification services. The laboratory provides a wide range of materials testing, corrosion testing and weld testing | Private sector | Member | element.com |
| 2 2 | All Seas | A contractor in offshore pipeline installation, heavy lift and subsea construction | Private sector | Member | allseas.com |
| 2 3 | Ahrenkiel Steamship | A technical ship management company, managing fleets | Private sector | Member | ahrenkiel-steamship.com |
| 2 4 | Bekaert | Company specialized in steel wire transformation and coating technologies. Supplier and services delivery | Private sector | Member | bekaert.com |
| 2 5 | MAN Energy Solutions | Provider of large-bore diesel engines and turbomachinery for marine and stationary applications. | Private sector | Member | man-es.com |
| 2 6 | Cavitar | Specialist and solution provider in illumination lasers based on diode laser technology. | Private sector | Member | cavitar.com |

Source: <https://ramlab.com/RAMLABsnetwork>

APPENDIX IV: Stakeholder Analysis

1. Name and organisation of the actor
2. What is the position in network and of the organisation or firm?
What is the position of the stakeholder in the network and to what firm or organisation is the actor connected?
3. Is the actor an internal or external stakeholder?
In this research an internal stakeholders equals a network member, all non-member stakeholders are considered external.
4. What is the knowledge expertise and are the resources of the actor?
What is the specialisation of this actor? (because the specialized level of innovation networks). To what resources has the stakeholder access? What does the stakeholder bring to the network?
5. What are the interests of the stakeholder (network member) in this network?
What interests does the stakeholder have in joining, staying or leaving the network? Which advantages and disadvantages?

Stakeholderanalyse – RAMLAB

1. Vincent Wegener, RAMLAB.
2. Managing director of RAMLAB, co-founder of RAMLAB. Is seen as a network manager and project manager. Important position in network and in RAMLAB company.
3. Internal stakeholder; core of network.
4. Connecting, coupling, binding and unifying factors. Managing director, boundary spanner. Organizes and leads network.
5. Interested in staying in network (logical; is core / founder). Want RAMLAB to be able to grow from a start-up to a fully-fledged company.

Stakeholderanalyse – Valk Welding

1. Peter Haspels, Valk Welding.
2. Sales manager at Valk Welding (company specialized in welding technology and the surrounding processes of welding). Valk is seen as a prominent actor within RAMLAB, also known as a key member. They are often present at RAMLAB and involved in the process and projects. They have been involved with RAMLAB from the start.
3. Internal stakeholder; partner in network.
4. Robot supplier, they offer a total solution concerning welding technology. So the control programs and the welding process.
5. RAMLAB is one of the first to use 3D printing with metal and welding. This is a (relatively) new technique, in which Valk saw potential from the start. They want to ride along with this technology and innovation.

Stakeholder analysis – M2i

1. Viktoria Savran, M2i.
2. Program manager of M2i projects (materials and innovation institution; network organization).
3. Internal; a network partner, not of RAMLAB company. The researchers designated by M2i are present every day at RAMLAB.
4. Link academic world with industry. They have linked researchers and PhDs to the network: therefore people + knowledge side. In addition, trying to link actors to RAMLAB, because they themselves are a large network organization in the field of materials industry and innovation and have therefore large reach.
5. Support of further development of the WAAM technology and thereby link the right actors to the network. Promoting collaboration between academic and materials. 3D printing gives opportunities to further develop materials and M2i wants to see this development.

Stakeholder analysis – Fokker GKN Aerospace

1. Marko Bosman, Fokker GKN Aerospace.
2. Chief Technologist Additive Manufacturing at GKN (global aircraft company).
3. Internal: member; (potential) end-user; involved with RAMLAB from the start.
4. Aviation Engineering (vliegbouwkunde) has been working with AM and WAAM for some time. Therefore experience brought in at the beginning. Also have research / study conducted and therefore more knowledge about WAAM (see WAAM as good technology).
5. Keep a close eye on WAAM technology. This can be done in a relatively cheap way via RAMLAB. Exchange of knowledge and experiences with network

Stakeholder analysis – Damen Shipyard

1. Timo Kreule, Damen Shipyard Group.
2. Research Engineer in R&D department of Damen.
3. Internal: member; end-user.
4. Providing cases for application of WAAM -> as an end-user you can submit cases and they can be examined in this way to see if it is worth anything (example: propeller). The possibility for RAMLAB to research a case study.
5. See if 3D printing can be applied when building ships. RAMLAB contains dedicated researchers with a great deal of knowledge (more than we could have for that money and time). To investigate the technology and see what it takes to classify it. At RAMLAB they have researchers from TU Delft and Twente with high-quality knowledge about WAAM, materials and the process. And they have the right contacts within the network.

Stakeholder analysis – Valk Welding

1. Cees Wieringa, Valk Welding.
2. Sales Manager Robotics at Valk Welding
3. Internal: key partner; robot supplier; involved from the start.
4. Knowledge of programming and welding; supplying the robots. Programming offline. The basics of robot programming have been taught to RAMLAB in the beginning.
5. Follow the development of WAAM. RAMLAB does intensive research into material and the process, and we hitch on that. And if technology is viable, we can install robot / installations by end-users. So then it could start generating new customers/market. We look at whether the 3D printing is well applicable.

Stakeholder analysis – Voest Alpine

1. Johan Cobben, Voest Alpine Bohler Welding
2. Responsible for WAAM, location Netherlands of Voest Alpine (developing (among other things) welding material for WAAM; producer of additives; specialized in materials).
3. Internal: member; connected since 2 years; places cases in RAMLAB, occasionally projects.
4. Knowledge and experiences used to look at possibilities within RAMLAB. Financial contribution, expertise and technical knowledge and use can be made of the Voest Alpine product palette. In addition, the application of cases and the technical exchange program (sharing of outcomes testing).
5. Optimize and improve products so that they are better suited for WAAM applications. Participate because: do our products meet the wishes of partners / users (quality)? Developments + explore possibilities of WAAM. Keep an eye on WAAM. Performing feasibility studies. So use RAMLAB facilities to gain insight into the possibilities and successes of RAMLAB.

Stakeholder analysis – Autodesk

1. Kelvin Hamilton - Autodesk.
2. Collaborative Research & Innovation Team of Autodesk (software company).
3. Internal; partner; from the start.
4. Providing the software for robots, providing tools, programming to automate the whole process or WAAM.
5. Shared vision: Making WAAM bigger in the industry. Synergetic, technological interdependencies. Creative spirits to push boundaries. Symbiosis. In the end people buy their tools as well, so Autodesk gets something back.

Stakeholder analysis - RAMLAB

1. Di Castri, RAMLAB, materiaalkundige
2. Material engineer, focusses on materials using WAAM. Communicates progress in meetings and contacts members that are related to materials.
3. Internal: RAMLAB, core: RAMLAB employee
4. Material engineer; focussing on materials of WAAM process.
5. Is an employee, so interest in making WAAM a success.

Stakeholder analysis: RAMLAB

1. Matthijs Visser, RAMLAB.
2. Software and mechanical engineer, focusses on process (software). Communicates progress in meetings, contact with robotics and software.
3. Internal: RAMLAB, core: RAMLAB employee.
4. Software engineer; focusing on process of WAAM; robotics.
5. Is an employee, so interest in making WAAM a success.

APPENDIX IV: Notes Made of Interviews

Interview Vincent Wegener

Striking about the interview:

- Says a lot about network management (his proceedings).
- Much about network analysis, extensively told about the origin of RAMLAB.
- Network decision making lies with RAMLAB.
- RAMLAB start-up, the rest of network the companies larger. Therefore maybe a different position.
- Institutional design: sponsorship agreement, NDA + agreements 1 on 1 projects. Not sharing knowledge gained outside the network.
- Vincent sees himself more as a managing director than a network manager.
- Advantages of RAMLAB because it is a startup, so it can act faster and collaborate more easily (no problems with legal / established procedures).
- Network management: organize meetings, involve everyone, 1 on 1 projects, projects for partners, process feedback, provide knowledge updates, approach people, seek partners for projects, make strategic choices, grow trust.
- From day 1, immediately popped ("knallen!") as RAMLAB, it was hit the ground and running immediately. That is the power of the network and cooperation: they are cutting edge.
- Exchange of resources and knowledge is important. Build together and build knowledge together in RAMLAB.

Interview Peter Haspels

Striking about the interview:

- Rotterdam mentality in network: being direct and saying what it's all about, don't turn around it.
- Want to help each other, deserve/award each other (*gunnen*). Certainly because RAMLAB is a start-up and they (especially in the beginning) really needed each other/members.
- Collaboration is mostly a relationship with RAMLAB itself, this is important, and the network of other members is something you get for joining the network. Commitment is therefore more to RAMLAB than at the network.
- Network management: organizing meetings, bringing each other into contact, getting involved in projects, publicity. Positive about management. Not really management of complexities, because does not experience/ are not in the network; also depends on business perspective: go for it and be rational.
- Network management is very important for collaboration, this keeps everything together and as a result the network is managed; the network stays that way.

What is good collaboration / factors of good collaboration:

- A lot of trust back and forth is important, together you have to make it and together you must get there.
- You must try to understand each other.
- You have to award (*gunnen*) mutually, which means that you have to give and take in good faith.
- Location plays a role: it is close to each other, so you can easily walk past each other.
- You have to help each other a little, for example, customers visit RAMLAB and they are open to this. Winwin
- Direct contact, openness, honesty and trust are very important (most important).
- Network management has the role that the network functions, is in contact with each other and is kept together.

Interview Viktoria Savran

Striking about the interview:

- M2i is a non-profit organization → but still connected to top sector government policy (public).
- It is a network organization with expertise in knowing the industry, existing networks and related actors. They want to encourage collaboration between universities and industry (triple helix).
- Input from Phd+ researchers and emphasizes the importance of collaboration with academia in establishing RAMLAB in order to develop successfully. This closes the gap between industry and the academic field. M2i does this, among other things, through a program where fundamental knowledge (from uni) is made applicable to industry.
- Want to help RAMLAB to develop further (deserve factor; *gunnen*). As an organization they want to be involved in material development and thereby help, think along, link network and help to make it applicable.
- Researchers are knowledge carriers.
- Goodwill agreement with RAMLAB.
- People get out if they don't get the feeling that the network or cooperation is useful to them, if it doesn't meet expectations. So it has to contribute something, otherwise they will leave the network.
- M2i has actively helped set up the network.
- Knowledge sharing (process + material) important in this network → but important that you understand the whole process → but this is complex.

What is good collaboration / factors of good collaboration:

1. People's attitude. RAMLAB and the RAMLAB network consist of super motivated, radiant, enthusiastic people. They want to move forward and want to do this well and as quickly as possible. That is good for the network and collaboration itself, good for quality, good for industry. People are key. They are the ones who want and need to push the technology.

2. Use of entire value chain in network. As a result, you are not bothered by competition in your network. And this does not cause friction (also protected with IP rights). RAMLAB is selective about who is admitted to network, so that competition in the network is avoided as much as possible.
3. Interest must be mutual. There must be something for all parties.
4. RAMLAB environment: it is a great environment that stimulates interaction. This in turn leads to building relationships.
5. Physical contact is very important. The meetings bring everyone together, the moments of coffee break or getting a sandwich are important. This gives room to communicate and new possibilities arise. So the contact moments are very important.
6. Trust. You can't get far without trust. Knowledge and technology must remain within the network (because you value a lot and otherwise you lose your competitive advantage), you must be able to trust people for this and this trust is very important. In addition, trust is important if you want to be an open network. This emphasizes the reason that RAMLAB is selective with whom they keep in their network.
7. Network management: maintaining contact, organizing meetings, clever planning, maintaining contact is very important. RAMLAB is management and Vincent then the manager. He does this well; he is not a technical but rather a network administrator (*beheerder*).
8. The network function of the network. On the one hand, companies need to learn something from the network so that the company can benefit from it. But on the other hand the network function is very important. This gives access to other companies and that is successful. "The value that people gain access to other companies and talk to people is sometimes more important than technical development itself."

Interview Marko Bosman

Striking about the interview:

- Learning from other industries.
- Geographical environment Rotterdam-Dordrecht has much interactions within industry + are closely linked together and want to help each because of this. → And thereby learn from each other.
- In RAMLAB because they want to stay up-to-date with 3D / WAAM knowledge. It is cheaper than setting it all up internally (so interdependency and exchange members important).
- In network: exchange knowledge and experience. Thanks to this network you can continue to learn from each other.
- In network: Bridge between academia and industry. RAMLAB is practical and looks for application.
- Advantage of RAMLAB: is an informal and relatively small group. Informal by the type of people + setting. This invites you to talk openly and honestly.
- Cross-sectoral exchange: learning from each other, from different companies.

What is good collaboration / factors of good collaboration:

1. Deserve (*gun*) factor: wanting to help each other. If a request for help comes, and you can and want to fulfill it and gladly help each other.
2. IP is important for sharing. Because Fokker wants to keep the difference that they have on the market.
3. No direct competition in the network: being able to talk and act freely. If there is more competition, then more fear of sharing. Now there are no partners who can do harm as competition.
4. Quality of technology and expertise of RAMLAB: interaction with TU contributes to this. This ensures that the network is more progressive and there is more innovative power. Collaboration with academic field / TU leads to that the horizon of TU has been broadened, also because you can submit your questions to them.
5. Type of people: open attitude of partners. Nice way you interact, and therefore you can say everything. RAMLAB staff is open and honest. Cooperation in a decent way.
6. Location: MakerSpace invites to talk and collaborate.
7. Informal atmosphere: People and the setting contribute to this. The informal atmosphere contributes to the collaboration. The threshold for sharing is therefore lower and in this way the network functions faster.
8. Trust: Good, great mutual trust. There is no competition in the network, which contributes to this. Be open and honest without problems. The informal atmosphere and environment of MakerSpace also contribute to → environment.
9. Wins: contribute to collaboration. RAMLAB shows progress and emphasizing the win is an incentive to continue working together.
10. Network management: marketing, PR. Organize meetings (with more projects, more meetings needed, because there is more knowledge to share). Projects run reasonably fast and well. This is also due to the informal atmosphere. Knowledge is shared through meetings. What is missing here is a joint site or joint archive. The management is to keep the network together and that is going well. This is also because the people in the network want it to go well; this makes managing this network easier.

Interview Timo Kreule

Striking about the interview:

- Interdependency = win-win at the same time. RAMLAB case (gains knowledge and further research), Damen gets answers on case and learns. RAMLAB gets a case to investigate + they can see what is needed to classify 3D printing, and Damen gains knowledge and skills that they can use to make ships better.
- Advantage of joining RAMLAB for members: they use the network very well. Otherwise 30 companies would have to do the same research, which is a shame. This is a fairly cheap, easy and also nice way to gain knowledge. And there are dedicated researchers at RAMLAB who have a lot of knowledge.

- Incentives to connect: PR: "putting on the map" as an innovative company. In addition, you can submit end-user cases that they select for you and you are there to "not want to miss the boat".
- Rules: collaboration contract. And if you conduct a joint research / case, then there are agreements about that collaboration, the knowledge gained and the results. The progress and superficial / general knowledge are shared, but the deep substantive knowledge is not shared. This remains between the company and RAMLAB. RAMLAB retains ownership of this knowledge.
- Knowledge: you have to protect this, because that is the most valuable part of the network. The knowledge is central at / in RAMLAB.
- Explanation about the making and cooperation regarding the propeller.
- RAMLAB structure: everyone has their own tasks, focus and specialism and this is linked to each other. This is a very good structure for research-like/innovative collaboration networks. That way you can do projects together and see what works and what doesn't.

What is good collaboration / factors of good collaboration:

1. Good collaboration in RAMLAB is that when putting a case forward, this is picked up and the capacity is available for it, that people learn from this and that you understand the usefulness of the case/WAAM. This way you learn from it together and it will both benefit you. And that you can go to RAMLAB with your questions and cases.
2. Trust: no reason in RAMLAB not to trust each other. Because there is limited cooperation between the partners themselves. Confidential information is not/only partially shared with everyone and is protected, and shall also not be shared outside the network. Also because there is no direct competition, it is easier to trust each other. Nobody builds boats, so no worries about that.
3. Competition: If there were competing parties in the network, you should be more careful with what you share and what you say. Not being each other's competitors contributes to easier knowledge sharing and occasionally showing something.
4. Shared vision / clear mission: The objective is to gain knowledge about 3D printing together. It contributes to the cooperation if the goal and vision agree between the partners. This is stimulating. If the noses are heading in the same direction, collaboration will improve. This is experienced in RAMLAB by Timo.
5. Seeing results contributes to good collaboration. You receive an update every three months and if you want to learn something about 3D printing you are at the right place.
6. The most important value of the network is knowledge (which is mainly with the researchers).
7. Network management: Maintaining contact with partners, organizing meetings, keeping everyone informed of what is happening, bringing companies in contact with each other, project leader of all projects. RAMLAB company ensures that the RAMLAB network stays together (but it is also their task, because it was set up by them). "Yes it is brought together by them". It is their job to make the network work. Vincent knows very well which organization has which knowledge and whether they have something to offer in a project. The network is so diverse in terms of companies, and I think they have a good overview of it. And that is very important to be successful. So: know who to find, disseminate knowledge at the right times and have an overview of the network: network management. But in this network that is fairly easy.
8. Have good mutual contact, so you don't have to be reticent.

Interview Cees Wieringa

Striking about the interview:

- Seeing if the process of 3D printing can be applied properly.
- Institutional design: Normal way of using rules in this network → you have to be a member, you pay for that and you get knowledge and updates in return.
- No points for improvement in collaboration. Works well. Only RAMLAB has to remain/stay innovative.
- Members have a proactive attitude.
- Complexities (management): you do not notice so much from complexities in the network. In the beginning it had to be decided "Where are we going?" What do we want? etc. But now that is running. This runs via Vincent / RAMLAB and not via the network. But this contributes to the degree of professionalism, otherwise you will never get everyone in the same direction.
- To keep the network up and running, there must be some new innovations, then it retains the positive image that appeals to many people.

What is good collaboration / factors of good collaboration:

1. Attitude / type of people important for cooperation. There are young, smooth (*vlotte*) people in RAMLAB. The type of people in the network contribute to the proper functioning of the collaboration. There is a high pace (*tempo*) in the network and that keeps people happy. People's input is also important. People are really interested in the things they do. They look to the future and what they can do with it.
2. Meetings are there to catch up, to stay informed and to see what is being done and what the results are. People who are most present at the meetings also give the most input. At the meeting you ask questions and you see results and you are in the mood (*sfeertje*). You talk to other people, so you can hear and share experiences of others. This is a good method. The meetings are interesting, there is a nice atmosphere and something is happening. You really get to see something. It is more active than most research networks. You get insight into what has happened, if this is not sufficient then you can always ask questions, and they are always answered.
3. Location of RAMLAB is stimulating. Exchange takes place. The hall is full of innovative companies. Something is happening.

4. High quality of work that is delivered. Research into materials, structure etc. It is professional at RAMLAB and it is about high-quality knowledge.

The knowledge (innovation management) exchange takes place at the meetings. And you go home with slides. And that they divide the info in such a way that it is and remains interesting for everyone. If it becomes too complex, people will drop out; it then becomes too complex in terms of content.

5. Achieving results quickly; and achieving things quickly also leads to more brand awareness and publicity.

6. Trust: Being open about results or testing creates trust. In addition, results are told fairly extensively at the meetings, which also creates confidence. And being at the meetings, ensuring that you are there and collecting and exchanging experiences also contributes to this. Good testing and achieving positive results also contribute to trust, mutual trust and confidence in the possibilities of RAMLAB.

7. Shared values and goals: People in the network are all connected to innovation or an innovative job, so many have an innovative approach. They share values, an interest.

8. Network management: Vincent: everything comes and runs through him. Tasks: Keeping in touch with everyone involved, he does that well, very clearly. He has gathered people together. How does he keep these people together? The informal atmosphere of RAMLAB, the environment (building) and the innovative aspect: attracts a certain group of people. Network management is very important. This drives everything, so it is very important. 100% the basis of proper functioning of the network.

Interview Johan Cobben

Striking about the interview:

- A lot about interdependency and resource exchange. Interdependency = cross-pollination (*kruisbestuiving*): mutual influence. You have to complement each other, make use of each other, give feedback to each other and learn from it. Resource exchange: resource is experience and knowledge, the exchange of experience development. You use each other's experiences.

- Making an investment in RAMLAB, but it takes off the work of your hands (doing feasibility studies, for example), so that investments pay off in the long term.

- Knowledge = of a technically high level -> TU boys and PhD students. The knowledge revolves around the WAAM, the practical implementation and application thereof. It must be a match between the metallurgy (*metaalkunde*) and the product. There is a lot of knowledge thanks to the TU / engineers and experiences from the network.

- Incentives for participation: rapid growth of new participants -> network function of the network. Relatively low investment for what you get back (knowledge, updates and development). In addition, the accessibility and communication of RAMLAB right/good from the start.

- WAAM: innovative: still in its infancy: for the future, it can have interesting added value. As a company (VoestAlpine) we had to do something with it, we believe in this technique.

- Network function: the network must grow, but the technology must also continue to grow. The network must become larger because it has added value. This gives you more perspective and you see more options for technology / WAAM.

- Assessment agencies (*toetsingsbureaus*): WAAM is unfamiliar, not yet a formal assessment protocol for WAAM. That makes it difficult (complex) and inhibits the process. Substantive complexity: interpretation of right/wrong/may/may not be unclear at WAAM and can be assessed differently per agency. Difficult in a conservative world to formally get through innovation (institutional complexity?) -> restraint in a sector where development is faster.

- Rules: no restrictions are imposed by means of rules in collaboration. Openness and freedom of action are central, questions can always be asked and comments can be made. Extra rules are only imposed on joint projects. Informal rules: open, free and fair acting: transparency. Transparency is preferred in cooperation. Also: Pay to participate in the network. Results come out and have to be shared. That is part of being a participant. And that is what you expect and you trust that, also kind of rule/assumption.

- Dedication: the more you open up, the more others open up. That is where the collaboration begins.

- Collaboration is mainly through RAMLAB / Vincent. The cooperation with the members themselves: little contact with participants. Not outside of RAMLAB.

- Complexities: if parties do not agree, this will not be discussed in public, but behind the scenes (institutional design). It is thought that substantive / strategic / institutional complexity has not actually occurred in the network. However, complexity with the assessment authorities exists.

What is good collaboration / factors of good collaboration:

1. Openness in cooperation is important. 100% open, free and honest attitude from RAMLAB. This shows transparency: and this in turn leads to the benefit/deserve (*gun*) factor: which in turn depends on the contact. This together leads to the achievement of successes.

2. The level of knowledge, product and expertise are important for collaboration and communication.

3. Success in the network by: being physically present (meetings are important here, not just via email contact). In pause during the meetings you create moments, communicate with other members. You can exchange experiences there. The part of 'networking' with each other is important: showing interest in each other, approaching each other.

4. Interdependency: we use them for the network and the technical knowledge and they use us to reach a higher level. Also exchange of location "visiting each other". Share results to get further.

5. Network management: Vincent: great leader of the team. -> ultimately makes the decisions.

Tasks: contact point for RAMLAB staff, contact point partners RAMLAB, maintenance contacts, looks for new possibilities, he arranges this if he wishes, returns to his remarks, agreements, represents RAMLAB, collects projects, gives overview of current projects, does the talking, project owner, central point of contact RAMLAB, he is available and present:

"he is there if you need him". Knowledge management: knowledge sharing is very important in this network. And willingness to share and complement each other in knowledge play a major role here. The most important is the practical implementation (gap between academic field and practice close) and the available high-quality knowledge. Management in general is very important, otherwise the network will fall apart. The right of existence of the network is that a kind of web is created and management must ensure that these wires are and remain connected. Transparency is important here.

Interview Kelvin Hamilton

Striking about the interview:

- Participation: Vincent approached Autodesk via Youtube video → had a coffee together → had shared interest.
- Shared mission + vision: making WAAM bigger + synergy, technological interdependencies + creative spirit to move boundaries. Vision = collaborative vision.
- Rules: partnership agreement.
- Autodesk is there to support them. Helping: "help them grow". We all want to be there, because we see a need and a reason for being there.
- Emphasizes interdependency → clearly explained.
- Explains difference between partners and members + structure RAMLAB. You have more to say as a partner in the network, because you work together more and there is more interaction. But: end users have the biggest say: they steer the process.
- Democratic technology and WAAM process: mission of Autodesk. More accessible to a larger group of people. Make more people learn about WAAM, equipment, software, hardware and skills. So it is more accessible to more people.
- In RAMLAB to learn while developing technology/knowledge

What is good collaboration / factors of good collaboration:

Why does RAMLAB collaboration work best? When partners are open, sharing, some level of commitment, taking and giving, shared vision and having a focused view.

1. The network / RAMLAB is inspirational (inspirational scenery), the setting and great space (= collaborative and inspirational).
2. Vision of RAMLAB and its people. (having a shared mission and vision)
3. Team that works together on problem solving.
4. Collaborative mindset or partners and members is important.
5. Inclusive and open way of collaboration. Inclusive: of terms of people, background. Also differences of thoughts and opinions. A diversity of thoughts what makes this collaboration work. It enhances creativity and unique solutions.
6. Network management: RAMLAB / Vincent manages. The management brings participants together. Go to RAMLAB whenever I need them. Management for connections with other partners.
7. Face-to-face / meetings are very important. In meeting openly, friendly talk with people. Innovation Dock is a great place. Get a summary of what's been happening and what's coming. Having this regular touch point is very important, having a connection is important. 1 on 1 projects means more input and more feedback directly.

Interview Matthijs Visser

Striking about the interview:

- Currently working on certification, is not an easy process. Even the certification process is the process they need each other for, "you cannot do this alone, the entire chain must cooperate, otherwise you will never get the plan on the table". (interdependency)
- RAMLAB is a central hub within the network; the connection between all companies. Companies are or specialists in certain products, producers, end users, knowledge.
- The advantage for some who are in a network is that this creates a new market and they may then be able to sell products.
- Interdependency / knowledge: a lot of knowledge is needed, from different specialisms, for that you need each other. There are many facets, and you need everyone and all knowledge to come to a good product.
- Management: inter alia keeping competition out of the network,
- Difficult: certain things that may not be shared i.v.m. confidentiality; how much do you share within a network? But, on the other hand, less importance is attached to it because members are often interested in a single piece (eg only feedback on gas or material type).
- Objective RAMLAB: to deliver fully automated, high-quality product.
- Drawing up a contract: about knowledge and licenses and to what extent things (including with third parties) can be shared and of them can be shared with RAMLAB.
- Members: people are all very enthusiastic, but also very busy but still find time for this. Evidence of enthusiasm.
- Knowledge is very important for this network. You need the partners to gain sufficient knowledge and move on, specializing yourself in every part is a lot of work. So interdependency. Good communication is important to gain that knowledge.
- Resource input reasonably balanced. O.a. by rules in contribution etc. But end users have more influence on what they want during a project. But RAMLAB does set a general course, they steer this. Only projects are the end users more dominant.

What is good collaboration / factors of good collaboration:

1. "Well, what we have now! So come together every three months, and present what you have done, then they can give feedback on it, so then at least every three months you have feedback, and yes, make use of your partners. So that you actually maintain good contact. That is actually the ideal situation. That you step towards each other, it must come a bit from two sides."
2. Openness and a proactive approach. You have no use for a partner who does not show up, who does nothing and does not help. You have nothing to do with that and you don't have to put any time into it. So it is best for something or someone who simply acts and participates proactively in the process.
3. Openness and open attitude very important
4. Proactive attitude members (depends on open attitude), want to help each other and do this quickly (so no week of responding time).
5. Clarity in contact / good communication, thereby preventing miscommunications (saves a lot of work and ensures progress). The informal atmosphere in communication plays a role here, it goes so much faster, so that progress can be made faster.
6. Trust (but depends on openness / openness). You build trust and expectation from and towards each other over time, you should not harm that. If trust is built up, there is more sharing / openness of affairs, trust in ability of RAMLAB.
7. Management. Without good management you would also have no partners, so those meetings are important, maintain active contact with partners, build relationships (trust).