Exploring the Use of Stakeholder Analysis Methodology in the Establishment of a Living Lab

Marius Imset, Per Haavardtun, and Marius Stian Tannum

> "*Interdependent people combine their own efforts with the efforts of others to achieve their greatest success.*"
>
> Stephen Covey (1932–2012)
> Professor and author of
> *The 7 Habits of Highly Effective People* (1989)

This article explores how to conduct a cost-effective stakeholder analysis to investigate opportunities and interest in establishing a living lab for an autonomous ferry connection. Using an action research approach, we share our experiences with the process and results, and we reflect openly on the strengths and weaknesses of both the stakeholder methodology generally as well as our own implementation specifically. According to the cyclic nature of action research and experiential learning, the research was conducted in two iterations, with the second iteration drawing upon input from the first. We compare and discuss these two approaches in terms of costs and benefits from a practitioner's perspective. The article provides a contribution to stakeholder analysis methodology for complex, multi-stakeholder innovation initiatives, such as living labs.

Introduction

Unmanned vessels are now fast turning from vision to reality (Øvergård et al., 2017), and the first autonomous commercial cargo ship, the Yara Birkeland, is scheduled for service in Norway in 2020 (Skredderberget, 2018). Informed about these developments, the public authorities in the Norwegian municipality of Tønsberg organized, in 2016, a dialogue meeting including industry and other stakeholders, aimed at replacing the existing 12-person ferry called the "Ole 3" (Figure 1), with a new environmentally friendly and autonomous ferry, named the "Ole 4". The idea and process were well received but did not result in any follow-up projects from Tønsberg municipality.

However, the process sparked further interest among a group of faculty members from the maritime and engineering departments at the University of South-Eastern Norway, who are the authors of this article. We obtained, in 2017, funding for a small follow-up project with a focus on navigational risk analysis related to automation. The comfort and safety of the passengers, as well as other nearby vessels and people, is paramount both in regular service and in case of incidents and emergencies. As part of the risk analysis, some interviews were conducted with the end users, including the ferry operator and passengers. However, in order to pursue the development of an autonomous ferry, including systematic involvement of end users, relevant organizations, and industry, a larger project based on more formalized collaboration would be needed. In order to prepare the ground for such an initiative, we decided to use an open innovation approach (Chesbrough, 2006; Tanev, 2011) and started to search for a specific methodology.

Figure 1. The "Ole 3" 12-person ferry (Photo by Tønsberg Sjømannsforening, used with permission)

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The quadruple-helix model (Arnkil et al., 2010; Miron & Gherasim, 2010) describes how industry, universities, users, and public organizations can work together to create a fruitful environment for innovation. According to De Oliveira Monteiro and Carayannis (2017), the linkages between these four sectors are indispensable for boosting innovation and productivity growth. The living lab methodology (Keyson et al., 2017; Ståhlbröst, 2008) implements a quadruple-helix model into an operational arena for innovation and provides a set of concepts, guidelines, and tools to help practitioners establish and organize these links into co-creation processes.

We chose to apply to the living lab methodology presented by Robles, Hirvikoski, Schuurman, and Stokes (2017) as the basis for an initiative with the goal of establishing a living lab around the Ole 3 ferry, and potentially other ferries as well. Living labs are concerned with generating value and benefits, in particular for end users, but also for the wider set of stakeholders. According to Logghe and Schuurman (2017), involving stakeholders is likely to encourage positive perceptions of the process and improve the quality of output and results. Stakeholders are "any group or individual who can affect or is affected by the achievement of the organization's objectives" (Freeman, 1984), so the task of identifying, understanding, and involving all relevant stakeholders in complex quadruple-helix environments may be quite costly, while the benefits, in particular in early phases, is uncertain. The use of panels has been presented as one useful method to handle stakeholders (see, for example, Schuurman & De Marez, 2012), but the applications seem to be restricted to processes focusing on end users. Although end users represent a central stakeholder group in a living lab, we found support in the literature that other parts of the quadruple helix may be more important, in the earliest stages, to the chances of success (Jonker & Foster, 2002; Savage, 1991). Also for living lab development, Schuurman (2015) emphasizes the importance of approaching the establishment of a living lab from the "macro" perspective, with a particular focus on the organizational level.

Research Problem

A broad stakeholder analysis appears to be a central and critical activity in the early stages of both innovation projects in general and in the establishment of a living lab in particular before a formal project and funding are in place. However, we found that there is a lack of practice-oriented research and more detailed guidelines on how to conduct such an analysis in living lab contexts. One practical aspect of obvious importance is the need to balance costs and benefits (Drèze & Stern, 1987). Thus, we address the following research question:

> *How can a cost-effective yet valid and reliable stakeholder analysis be conducted as part of an early-stage initiative in the establishment of a living lab?*

Methodology

Being both researchers and practitioners engaged in the Ole 3 ferry project, we have chosen to address the research problem by the use of an action research methodology. Action research is also recommended as an interesting and suitable approach to living lab research (Logghe et al., 2017; Ståhlbröst, 2008).

According to Greenwood and Levin (2006), action research is social research carried out by a team that encompasses researchers and members of an organization, community, or network that seek to improve the participants' situation. Action research consists of a set of main tasks, which we describe below in the context of how we have addressed them in our research:

1. *Define the problem to be examined:* We (the research group/participants) met and discussed our goals and challenges, which resulted in the research problem and question described above.

2. *Cogenerate relevant knowledge about the problem:* We conducted a literature review on living labs and stakeholder analysis methodology, attended conferences, discussed the topic with other scholars and colleagues, and drew on extensive personal experience from various regional development projects. Based on this, we developed a framework for the stakeholder analysis and defined a process on how to conduct it.

3. *Take actions to solve the problem:* We conducted the stakeholder analysis and had frequent communication during the process.

4. *Collect and interpret results:* We obtained results, which we summarized in tables and analyzed.

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5. *Reflect on the process and iterate the action research cycle for increased learning:* We discussed and documented our findings, experiences, and lessons learned. As both action research and other models for experiential learning (Kolb, 2014) emphasize the cyclic nature of knowledge development, we undertook two iterations, where the first provided input for the latter.

Research design

The research design is the blueprint that enables the researcher to come up with solutions to the research problem, guiding the various stages of the research (Frankfort-Nachmias & Nachmias, 2008). In our research, it implies the practical execution of the stakeholder analysis. As our basis, we have chosen the process described by Reed and co-authors (2009), which consists of the following steps: 1) Identify stakeholders, 2) Classify stakeholders, 3) Investigate the relationships between stakeholders, and 4) Reflect on the results and process.

According to the principles of action research and the nature of experiential learning, we adjusted the research design from the first to the second iteration to account for lessons learned. Thus, in the following sections, we describe each iteration, including similarities and differences in research design, as well as results and reflections according to an action research methodology.

The First Iteration

In this section, we summarize the first iteration of our action research study while emphasizing relevant methodological issues and reflections. For further details of this first iteration, please see our earlier paper on this topic (Imset et al., 2018).

Step 1: Identification of stakeholders

We used the framework provided by Ståhlbröst and Holst (2012) as a starting point for describing four main stakeholder groups for living labs: companies, researchers, public organizations, and end users. We decided to limit our scope to the Ole 3 project, making this a meso-level approach to living lab development (Schuurman, 2015). As a tool in our discussion, we found the 17 stakeholder roles identified by Nyström, Leminen, Westerlund, and Kortelainen (2014) to be helpful. Examples of such roles are advocate, producer, coordinator, and messenger. Together, we generated a list of 25 stakeholders that seemed relevant for the Ole 3 project at this stage, including ourselves as the initiators of the living lab initiative (i.e., the research group), those internal to the university and those in the external environment (private and public organizations). End users are key stakeholders in living labs, but without a common agreement with central stakeholders to commence with a living lab approach, as well as more solid funding, we found it immature at this point to start a wider involvement of ferry end users (i.e., the passengers).

Step 2: Classification of stakeholders

A classification scheme for our stakeholders and their attributes was made by combining the "rainbow diagram" (Chevalier & Buckles, 2008) with the attitude–power–influence model proposed by Murray-Webster and Simon (2005). Table 1 presents these five attributes and their definition.

Our approach to the analysis was to do a subjective evaluation internally in the research group, based on data from interviews, meeting notes, email correspondence, websites, and personal subject-matter knowledge from the Ole 3 project. For our interviews, we developed an interview guide addressing aspects related to the five attributes (Table 1). Once data was gathered, we met to rate and classify stakeholders according to Table 1.

Our findings, reflecting our own interpretation of the stakeholders, were that they generally have a positive attitude (scoring in the range of 4 and 5), but that the influence, power, and degree to which the stakeholders are actually affected, was quite low (scoring in the range of 1 and 2).

Step 3: Investigation of the relationships between stakeholders

For this step, we applied a one-directional actor-linkage matrix (Biggs & Matsaert, 1999). Reed and colleagues (2009) identify three dimensions of stakeholder relationships – conflict, complementary, and cooperation – and we chose to focus on the cooperative aspect of relationships, as we believed this was the most valuable at this stage. Then we undertook another subjective evaluation by scoring the strength of each relationship with values spanning from 1 (weak) to 3 (strong). A sample of the resulting matrix is presented in Table 2.

We found that there are significant variations in the strength of relationships between stakeholders. We also found differences in our subjective perceptions about both the nature of the relationships, as well as the relative strength of the stakeholders. Our stakeholder list contained both individuals and organizations, which added to this challenge. We recognized that relationships, even when our perspective is limited to collaborative aspects,

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Table 1. Stakeholder attributes and definitions on stakeholder properties

Attribute	Definition (adapted by authors)	Scale	References
Influence	To what degree the stakeholder is able to informally influence the living lab initiative	Least – Moderate – Most	Chevalier & Buckles, 2008
Degree affected	To what degree the initiative/project, and the outcome of it, will affect the situation for the stakeholder		
Power	How much power/authority is held by stakeholders of relevance to the initiative/project	Insignificant – Influential	Murray & Webster, 2005
Attitude	Stakeholders' current attitude towards the initiative/project	Blocker – Backer	
Interest	How interested the stakeholder is in the initiative/project	Passive – Active	

Table 2. Sample of results from relationship analysis

Stakeholder	01	02	03	04	05	06
01						
02	3					
03	3	3				
04	2	2	3			
05	1	1	2	3		
06	1	3	3		2	

contain many sub-dimensions that needed clarification in order to secure reliability and validity of this type of analysis.

Step 4: Reflect on the results and process
As the final step, we reflected on the result and process, both individually and meetings. The results of these reflections are described in Table 3.

The Second Iteration

Based on our experiences from the first iteration, we made a number of changes in focus areas and research design for the second iteration. One of these changes was to shift from the meso (project) to the macro (organizational) level, in line with recommendations from Schuurman (2015). With respect to defining the organizational context, we chose to focus on our internal environment at the university. This is because of the central role of universities may play as generators and facilitators of quadruple-helix collaboration (Arnkil et al., 2010), and because we know from several years of experience that solid internal support is a key success factor in projects addressing multiple external stakeholders. During the first iteration, we also identified other projects going on among faculty, which addressed the same categories of external stakeholders. Typical for academic institutions with a high degree of individual autonomy (Winter, 2009), there was no common structure for how we should collaborate internally or with external parties in this new area of research. Thus, an internal analysis seemed necessary before moving on with external stakeholders.

Despite the common practice with third-party, subjective evaluations in stakeholder analysis, we find this approach to be doubtful in terms of both validity and reliability (Frankfort-Nachmias & Nachmias, 2008). Thus, we wanted to measure the perceptions of stakeholders themselves, rather than using our own opinion. How a person perceives their fit with their job and organization was found by Cable and DeRue (2002) to be

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Table 3. Lessons learned in the first iteration of stakeholder analysis (from Imset et al., 2018)

	Lessons Learned	Comments
1	To list stakeholders is one thing, following up is another.	Secure time and resources, as well as good internal coordination. The creation of a living lab may need to be established as a separate, formal project with funding. Formalization may also increase understanding of the functions of a living lab and make it clearer for internal participants to understand what their roles and tasks are.
2	Start with internal stakeholders in own organization before moving external.	In a university environment such as ours, there is a plethora of related activities, projects, and stakeholders that need to coordinate in order to provide a coherent message to external stakeholders.
3	Plan and consider the first iteration of stakeholder analysis as an indication only.	Stakeholder analysis is considered to be an iterative process (Reed, 2009), and this aligns with our outcome and experiences. In terms of a living lab, we need to include end users as well, but will await this involvement until the organizational aspect is clearer.
4	Address individuals, not organizations, in stakeholder analysis.	It is ultimately people who will contribute or resist, so we found that addressing individuals was the most fruitful level of analysis. Mixing individuals and organizations into the same analysis made the work difficult.
5	Stakeholder analysis requires a clear, common understanding of classification attributes.	We developed and discussed the framework together in the research group, but should have defined the meaning of the terms more thoroughly to secure a common understanding.
6	A meso-level approach to the establishment of a living lab is challenging; a macro-level approach may make it easier.	It was difficult to isolate the project (meso) level from the organizational (macro) level when analyzing issues related to the living lab (confirming Schuurman, 2015). Thus, we believe it would have been better to start with a macro-level approach.

a better proximal determinant of attitudes and behaviours than the actual, or objective, fit. This supports the validity of data based on stakeholders' own perceptions of themselves and their relationships.

As our data collection tool, we chose to make an electronic survey. As constructs, we chose to continue with the stakeholder attributes according to Table 1, but our relationship construct applied in the third step of the first iteration needed revision.

Based on the challenges of separating the project from the organizational level in the first iteration, we also set forth to define a more focused, macro-level issue for the survey. This was of particular importance as we were to address the stakeholders directly. We also wanted to align our analysis with an ongoing strategic process on how to increase internal coordination and collaboration among faculty. Thus, we made the following introduction to the survey: "One goal in the faculty strategy is that we should improve internal communication, coordination, and collaboration. This stakeholder analysis is initiated to support this process: how we should organize our activities, with a particular focus on autonomous shipping (including ships, ports, logistics, and operations)." Note that in the maritime domain, shipping denotes waterborne transportation of both goods and people, including ferries.

The details of these adjustments in research design is elaborated below, under each step of the stakeholder analysis process.

Step 1: Identification of stakeholders

We used the same method as in the first iteration: defining a list based on our own perception. However, due to experiences from the first iteration, we now focused on people as individuals, and we ended up with a list of 13 stakeholders. Of the 13 surveys sent, 10 were returned. In order to secure anonymity, stakeholder names were replaced with capital letters. Acknowledging limitations in our own knowledge, and to obtain an increased understanding for future work, we also allowed respondents to identify new stakeholders they felt were

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relevant. Due to time constraints, these additional stakeholders did not complete the survey but were considered in the relationship analysis.

Step 2: Classification of (internal) stakeholders
We used the same five stakeholder attributes as defined in Table 1, but added available time as a new factor. This is because time is a resource that affects most aspects of human enterprise, and therefore it is a central parameter in practical cost-benefit trade-offs (see Hollnagel, 2017, for an interesting elaboration on this). The survey contained six questions, one for each attribute, and respondents were asked to indicate their answers by use of a 5 point Likert-type scale (Table 4).

The respondents' answers were entered in the same type of spreadsheet as in the first iteration (see Imset et al., 2018, for details) and were coded with qualitative labels according to Table 5. Table 6 shows the results of the survey, with mean score and standard deviation for each of the concepts.

We found that the interest (mean score 4.4) and attitude (4.3) among the stakeholders is much higher than their perception of what they can do to help make the desired changes (influence is 2.8 and formal power is as low as 1.8). Time seems not to be the limiting aspect, as this is rated higher (3.3). These differences indicate that, although people feel affected and interested, there may be a lack of formal or informal ways to influence in decision-making processes related to the organizational layer.

Step 3: Investigation of the relationships between stakeholders
We continued to explore the collaborative aspect of relationships as we did in the first iteration. Human relationships may be analyzed using dozens of parameters,

Table 4. Stakeholder attributes and range of possible Likert-type responses to related survey questions on stakeholder properties

Attribute	Survey Question	Lowest Value (1)	Highest Value (5)
Influence	To what degree do you feel you are able to informally influence this process?	No influence	Major influence
Degree affected	To what degree do you think this process, and the outcome of it, will affect your work situation?	No change	Will totally change it
Power	Based on your formal position, how much power/authority do you have in this process?	No control	Full control
Attitude	What is your current attitude toward this process?	Totally negative	Totally positive
Interest	How interested are you in this process?	No interest	Highly interested
Time	Do you have time available for improved communication and collaboration?	No time	Time is no problem

Table 5. Classification labels for each attribute (adapted from Chevalier & Buckles, 2008; Murray & Webster 2005)

Attribute / Score	1	2	3	4	5
Influence	Least	Least	Moderate	Most	Most
Degree affected	Least	Least	Moderate	Most	Most
Power	Insignificant	Insignificant	Insignificant	Influential	Influential
Attitude	Blocker	Blocker	Blocker	Backer	Backer
Interest	Passive	Passive	Passive	Active	Active

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Table 6. Table with properties of each stakeholder

	Time	Rainbow Diagram		Three-Dimensional Grouping			Label			Label	
Stakeholder		Influence	Degree Affected	Power	Attitude	Interest					
A											
B	3	3	3	1	5	5	Insignificant	Active	Backer	Moderate Influence	Moderate Affected
C	3	1	1	1	3	2	Insignificant	Passive	Blocker	Least Influence	Least Affected
D	3	3	3	1	5	5	Insignificant	Active	Backer	Moderate Influence	Moderate Affected
E	4	4	3	3	4	4	Insignificant	Active	Backer	Most Influence	Moderate Affected
F											
G											
H	4	2	4	1	3	5	Insignificant	Active	Blocker	Least Influence	Most Affected
I	2	3	4	3	5	5	Insignificant	Active	Backer	Moderate Influence	Most Affected
J	3	3	3	2	5	4	Insignificant	Active	Backer	Moderate Influence	Moderate Affected
K	3	3	3	4	3	4	Influential	Active	Blocker	Moderate Influence	Moderate Affected
L	4	3	4	1	5	5	Insignificant	Active	Backer	Moderate Influence	Most Affected
M	4	3	4	1	5	5	Insignificant	Active	Backer	Moderate Influence	Most Affected
Mean	3.3	2.8	3.2	1.8	4.3	4.4					
SD	0.67	0.79	0.92	1.14	0.95	0.97					

but including all of these in a survey would make the survey too onerous for the respondents. As we prioritized to make the survey accessible and quick to complete, we chose to explore two central properties. The first is intensity, defined as "the strength of the relation between individuals", and the second reciprocity, defined as "the degree to which a relation is commonly perceived and agreed on by all parties to the relation, i.e. the degree of symmetry" (Tichy et al., 1979). By means of our electronic survey, we measured the intensity of the relationship by questions addressing three sub-properties in line with Dagger and co-authors (2009): extent of collaboration, contact frequency, and motivation for increased collaboration in the future. The three questions are shown in Table 7 along with the Likert-type scale. Frequency intervals were also added to increase reliability.

In order to condense our analysis and data, we calculated the mean value of the two first questions in Table 7 as one value for the degree of current collaboration, whereas the latter questions represent the motivation for more future collaboration. The reciprocity (symmetry) of the relationship has been calculated as the absolute value of the differences in how two stakeholders rated their common relationship. This means that the lower the calculated value, the more symmetric are the relationships.

Table 7. Survey questions for measuring the intensity of each relationship

Question	Low 1	2	3	4	High 5
To what extent do you collaborate today with him/her on ideation, application development, or project work related to autonomous shipping?	Less than 5 hours a year	5–50 hours a year	50–150 hours a year	150–300 hours a year	300+ hours a year
How often do you have contact with him/her in order to discuss future collaboration and ideas in autonomous shipping?	Less than once a year	1–5 times a year	5–15 times a year	15–30 times a year	30+ times a year
Based on your current working situation and knowledge, to what degree are you interested in more collaboration with him/her on autonomous shipping?	Not interested	...	...	...	Highly interested

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The relational data are presented as social network diagrams (Scott, 2017) along with tables presenting more information about the nature of the relation (ties), with values for tie strength and reciprocity. Also, mean values and standard deviation (SD) were calculated. First, we present our findings for the current degree of collaboration, then for the motivation for increased collaboration in the future.

Strength of current collaboration

We received data on a total of 82 ties, of which 44 were mutual (Figure 2). The difference in these numbers are due to the fact that three respondents did not return the survey and because some respondents added new stakeholders to the list. Details of these ties are provided in Table 8.

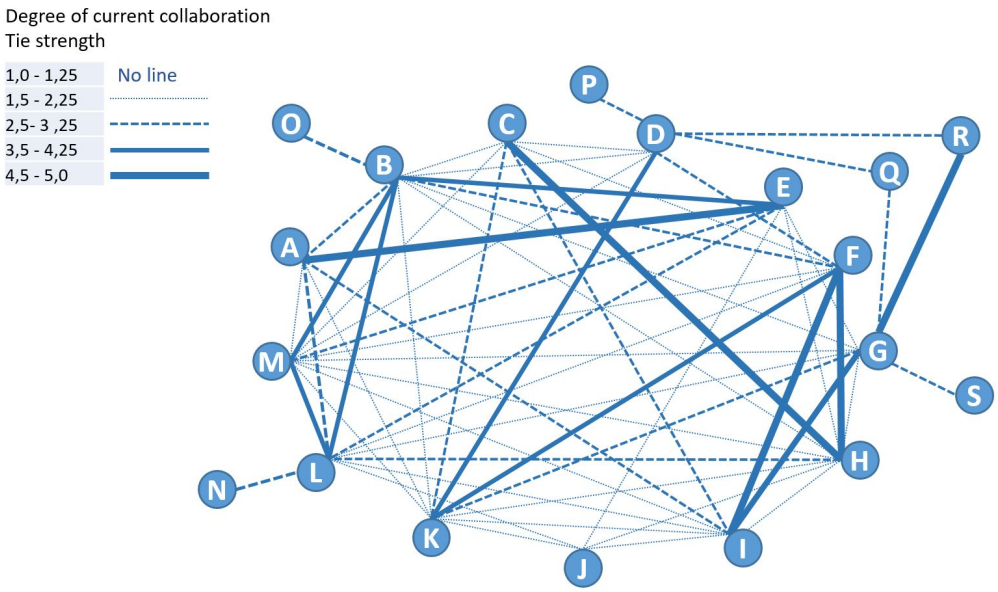

Figure 2. Social network diagram illustrating the current degree of collaboration (time spent together and contact frequency taken into account) between the stakeholders. Tie strength ranges from 1 (low) to 5 (high). The initial 13 stakeholders (A to M) are placed in a central group; stakeholders added during the survey (N to S) are placed outside the group.

Table 8. Overview of variation in tie strength and reciprocity in current collaboration. Mean value of all ties = 2.08; standard deviation of all ties = 1.09.

Tie Strength	
Value	**Count**
1–1.25	22
1.5–2.25	30
2.5–3.25	19
3.5–4.25	5
4.5–5	6
Sum ties	**82**

Mutual Ties/Relational Symmetry		
Value	**Count**	**Reciprocity**
0	10	High
0.5	17	·
1	9	·
1.5	4	·
2	4	·
Sum mutual ties	**44**	Low

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We see that the existing network has some degree of collaboration, but most ties (42) are at 2.25 or lower (i.e., towards the lower end of the scale). The overall mean value of 2.08 is influenced by a few strong ties (11 are rated at 3.5 or higher). This is reflected in the standard deviation of 1.09. It seems as though relationships are quite symmetrical, as 27 of the total of 44 mutual ties has only 0.5 or less difference in score. However, there are also some examples of big differences, there are 8 ties with 1.5 or 2.

Motivation for increased collaboration in the future

For future collaboration, the mean value is 3.65, which is towards the upper part of the scale. Thirty of the 44 mutual ties have values of 1 or less, indicating a high degree of symmetry. But, there are also 4 relationships that score 3, meaning that one party is highly motivated for more collaboration, while the other is not. Lack of symmetry does thus not seem to be a big challenge, as the majority of relationships are based on mutual expectations and motivation. A high degree of symmetry was also confirmed by computing the averages of the overall received and delivered score values among the respondents, where we found only a slight difference (0.2) related to one issue (contact frequency). Details of these ties are provided in Figure 3 and Table 9.

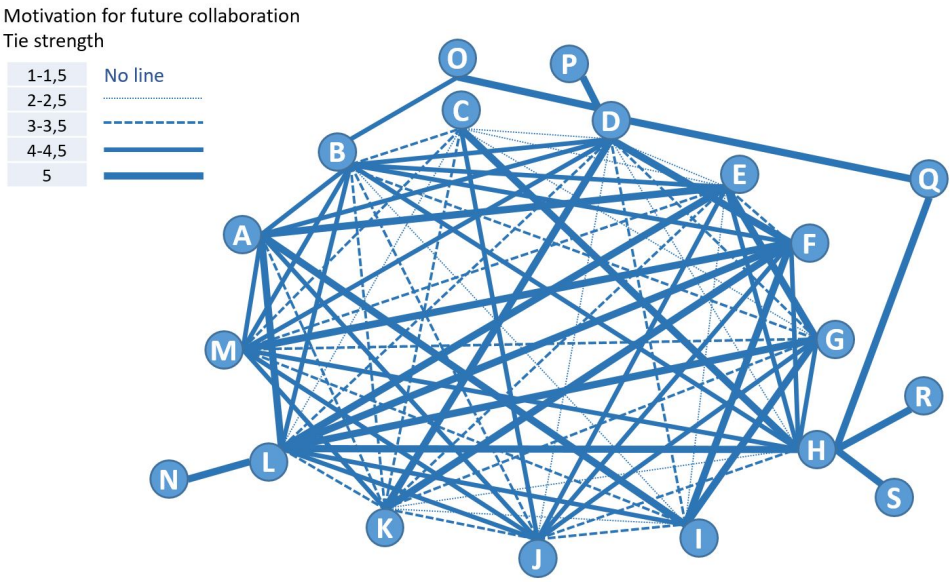

Figure 3. Social network diagram illustrating the degree of motivation for increased collaboration between the stakeholders. Tie strength ranges from 1 (low) to 5 (high). The initial 13 stakeholders (A to M) are placed in a central group; stakeholders added during the survey (N to S) are placed outside the group.

Table 9. Overview of variation in tie strength and reciprocity for increased collaboration. Mean value of all ties = 3.65; standard deviation of all ties = 1.26.

Tie Strength	
Value	**Count**
1–1.5	4
2–2.5	12
3–3.5	20
4–4.5	24
5	22
Sum ties	**82**

Mutual Ties/Relational Symmetry		
Value	**Count**	**Reciprocity**
0	12	High
1	18	·
2	10	·
3	4	·
4	0	·
		Low
Sum mutual ties	**44**	

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We also analyzed how available time may affect the degree of motivation, and we found a moderate to high correlation (Pearson=0.53). This implies that people with less time are also less interested in increased collaboration, confirming that available time is an important attribute in stakeholder analysis.

Step 4: Reflect on the results and process

To us, the most interesting finding is the large difference between the current and desired degree of collaboration. Stakeholders feel that the degree of current collaboration is low, and that they would like to increase it in the future. This is promising for the establishment of a living lab. They also feel that there is time for more collaboration, but that their possibilities to influence (formal and informal power) how we work and collaborate is low. Given that the university is to become a central stakeholder in the living lab establishment, this seems to be a main barrier that needs to be further explored. Principally there may also be other leading organizations besides the university, or the living lab may also be based on other network models (Barabasi, 2002) that are not centralized. However, to our knowledge, few other relevant internal and external stakeholders are aware of the concept of living labs, and in our region, the university would likely be expected to have some sort of hub function.

We were also surprised to see that the degree of symmetry, or reciprocity, in the motivation for more collaboration is so high, when the degree of current collaboration is low. We interpret this as an indication of general positive attitudes toward getting to know one another better. Promoting the living lab concept may help to facilitate a better understanding of how to collaborate. We provide an overview of our lessons learned from the process in Table 10.

Table 10. Lessons learned from the stakeholder analysis method applied in the second iteration

	Issue	Lessons Learned
1	Relevance of findings	The method revealed findings that were highly relevant and interesting to our action research context. Asking respondents themselves increases data validity.
2	The process created engagement, curiosity, and awareness in the organization	We were approached by both colleagues and managers who expressed their interest, and we expect that the results will be received with great interest by the participating stakeholders.
3	Unit of analysis in stakeholder analysis	Addressing stakeholders as individuals made it easier to work systematically (compared to the first iteration), and we also found a lot of variation within the organization.
4	Data privacy	Some respondents were very concerned about data privacy. Although we formulated our questions to address strictly professional aspects of the relationship, some of the respondents felt that data concerning relationships between colleagues was principally sensitive.
5	Anonymization	Due to ethical principles in science (anonymity), we chose to anonymize respondents. This may reduce the usefulness of the analysis in plenary discussions in the faculty.
6	Resource need for stakeholder analysis	Preparations, data collection, and analysis using this method is time consuming compared to a third-party assessment (where data is based on assumptions about stakeholder properties and relationships)
7	Limitations on the number of stakeholders	Adding a larger number of stakeholder into this type of survey, that also explores relationships, will make it hard to use in practice for the respondents. Based on feedback from our respondents we estimate that an upper limit of approximately 20 stakeholders is appropriate.
8	Keep it focused	Based on the feedback we received, we succeeded in providing a clear focus for this iteration.
9	Selection of respondents	As for the first iteration, we decided on which stakeholders to include in the analysis. In the second iteration, we allowed the respondents to add new relevant stakeholders into the survey data. We found this to be a valuable addition for follow up work.

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Discussion

Although the first iteration followed the basic principles of stakeholder analysis, the subjective approach and an ill-defined relationship construct reduces the scientific validity and reliability. Based on our limited literature review, this seems to be a common challenge in much of the available methodology, not only for living labs, but also for the wider field of innovation.

The second iteration used methods that are more reliable and valid, and with a scope and focus that we found more useful at our current stage. The actual involvement of the stakeholders also sparked engagement. However, there are practical drawbacks with these changes, which is that the second approach required significantly more resources and expertise. Still, there is a long way to go from our simple questionnaire to a scientifically solid scale measure (e.g., exploratory factor analysis: Costello & Osborne, 2005), but such development is outside the scope of this work.

Based on our experience with project development, we find it unlikely that practitioners are willing to undertake a very extensive analysis for exploring their stakeholders (potentially with the exception of systematic user studies addressing particular issues related to the product or service being developed). Thus, a simpler approach seems needed – one that still ensures a satisfactory level of reliability and validity. The similarities and differences of our two iterations is summarized in Table 11.

Conclusion

In accordance with methodologies for stakeholder analysis and action research, we conducted a stakeholder analysis in two iterations. We applied two different approaches in order to explore which is better in terms of costs and benefits for living labs practice. The action research has been conducted in the context of the initial phase of a living lab for increased autonomy in the maritime shipping industry. Due to the early stage of this project, we have chosen to focus on the internal organizational layer, before reaching out to external stakeholders such as industry and end users. Our research indicates that a thorough, scientifically solid stakeholder analysis provides higher value, but may be too costly or complex compared to simpler methods. We propose that our approach applied in the second iteration provide a good cost-benefit balance suited for living lab development and related open innovation initiatives.

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Table 11. Overview of differences in research design in the first and second iteration, including our evaluation of strengths and limitations of the two approaches

Aspect	First Iteration	Second Iteration
Living lab level addressed	Meso	Macro
Scope	Quadruple helix	Intra-organizational
Data collection method	Evaluating stakeholders (external assessment by the researchers)	Asking stakeholders using a survey (self-assessment)
Stakeholder types	Mix of organizations, groups, and individuals	Individuals only, but at different levels in the organization
Step 1: Identify stakeholders	Defined by research group/authors. In the second iteration, we allowed stakeholders to suggest other stakeholders.	
Step 2: Classify stakeholders research design	Researchers' perception of stakeholders	Stakeholders' own perception
Step 2: Stakeholder attributes	5 stakeholder attributes (Table 1)	The same 5 attributes, plus time
Step 3: Investigate the relationships between stakeholders	Researchers' perceptions of stakeholders One factor, uni-directional	Stakeholders' own perceptions; data collection by a survey Three dimensions Bi-directional
Step 3: Relationship construct	Collaboration; ill-defined	Collaboration; better defined, with sub-properties
Step 4: Reflection on the results and process	Research group only; during and after the process, individual, and in plenary	Similar as in the first iteration and also spontaneous reflections on methodology from stakeholders participating in the analysis
Reliability and validity	Low	Medium
Cost (sum of time spent from all parties)	Very low	High
Competence needed to use the method	Available to all living lab practitioners	More specialized expertise needed
Benefit from a practical perspective	Low, but useful as a trigger for more discussions and planning	High; the analysis provided more detailed and reliable insight

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