

## **Multi-criteria decision-making: A necessity for sustainable innovation.**

*How does an SME entrepreneur invest in sustainable innovation?*

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### **Summary**

The shift towards a more sustainable (circular) economy will require innovations. While SMEs can contribute to this development, financing innovations within SMEs is difficult. Various authors have noted moreover that the concept of the circular economy has further increased the complexity of investment decisions concerning sustainable innovations, due to the multiple value creation and new business models involved. On the other hand, the literature shows that intuition leads to suboptimal decisions, especially in the case of financial decision-making. Cases studies confirm that that investment decision-making are often motivated by more criteria than classical investment decisions and require a broader skillset from the entrepreneur, regarding both finance and cooperation. In this study we investigate these additional criteria and see how they influence successful investments in sustainable innovations

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## **Introduction**

The importance of a more sustainable approach to interacting with the world economy is increasingly influencing decisions by governments, entrepreneurs and consumers. Policy-making often follows governmental organisations in maintaining the seventeen ‘sustainable development goals’ (SDGs) formulated by the UN (2015) as the benchmark. This view also recognises that other ways of dealing with sustainability require different methods and new technological discoveries. In short: innovation. In this context, it is logical that the resolution (2015) in which the UN formulates these objectives repeatedly emphasises the importance of technological developments and innovation. As a result, innovation is explicitly included, as a part of SDG number goal 9. Smaller companies, start-ups, scale-ups, etc. are the source of many sustainable innovations. However, it is precisely this category of entrepreneurs that is facing increasingly complex investment decisions for sustainable innovations.

## **Increasing complexity for SME entrepreneurs**

Hall and Vredenburg (2003) explored the organisational and financial challenges associated with sustainable innovation. While innovation in general is already difficult, Van der Wal and Van Es (2010) demonstrated that this particularly applies to SMEs. At the same time, the importance of innovations is high for SMEs, according to the ‘SME insight’ monitor (*MKB in beeld*, 2014). Tirole (2016) also mentioned this as a bottleneck.

Jonker (2015) describes the changes in business models that go hand in hand with the transition to more sustainable forms of business. Noticeable shifts in this regard are the business models that are becoming more complex in the sense of multiple value creation: not only specific financial objectives are weighed, but so is the social return. Financial results as a goal are merely derived as a consequence from these objectives. In addition, the earning capacity is determined in a network of organisations and parties and no longer for a separate company. Types of commercial transactions are also becoming increasingly complex: sales from producer to consumer are no longer the rule. Instead, companies share ownership of goods and settle through means such as rent.

Above that financing innovations are in general difficult due to the so-called information asymmetry, in which it is not easy for the lender, the 'principal', to assess whether the concepts of the borrower, the 'agent', are financially profitable (Toxopeus, 2019). Moreover, since sustainable innovations come with complex revenue models, the financial decision-making issue has become even more complex for SME entrepreneurs.

In relation to these challenges in financing sustainable innovations, researchers such as Toxopeus (2019) are investigating the framework within which financing takes place. In addition, due in part to the socially recognised desirability of such financing, more specific measures have been taken in this regard. Governments, for example, offer a variety of subsidy options, in the form of investment contributions, subsidies for products, and guarantees (Netherlands Enterprise Agency). Commercial banks also provide subordinated loans for specific sustainable initiatives, and modern platforms for crowdfunding offer access to investors with social objectives. Insight in these processes is becoming also more important for governments. Indeed, after a number of decades wherein globalization and deregulation were the norm, and policy makers should not try to control the free market, today a shift is notable worldwide. The World Economic Forum (2020) for instance states "There are signs of policy agility and business reform that may lead to a different, better kind of economic growth, but this momentum needs strengthening". This shift is considered to be necessary to yield more innovation and to attain environmental, social and governance goals.

Besides financing facilities, businesses can also generate extra income from eco-innovations by appealing to the increased consumer awareness with regard to sustainability, potentially supported by true pricing strategies (True Price Foundation, 2014). Many governments and companies also promote the market for such innovations through socially aware procurement policies. All in all, there is agreement from different perspectives that the financing challenge for sustainable innovations seems to be more complicated but, according to research, not impossible to overcome (Van der Hoeven & Bossert, 2019). However, solving such an issue requires more than the traditional business-economics approach to investment decisions, which every entrepreneur or company is naturally inclined to adopt. There is a risk, therefore, that SME companies in particular will miss out on opportunities.

## **From the traditional approach to the rationality of the decision-making process**

A shift from traditional approaches of capital investment to more modern approaches seems somehow necessary. Classical, theoretical business-economics insights about investment decisions (see standard handbooks, e.g. Arnold, 2012) usually regard investment decisions as the result of a strictly rational process. Tempelaar (1988) provides a motivation for this.

Conditions (usually implicit arguments) for this approach are:

- The presence of a clear goal (namely the net present value of the cash flows);
- The identifiability of the decision (whether or not to invest in the project); and
- Usually the need to convince external parties (in particular financiers) that the decision makes business sense.

This decision-making model has limitations. Simon (1955) demonstrated the limitations of rationality. Uncertainty is one of them. Magee (1964) tackled the uncertainty regarding the future in the decision-making process by relying on scenarios and stochastic models.

Mintzberg et al. (1976) showed that, although decision-making may not be rational, the decision-making process is structured, leading to the concept of 'emergent' decision-making.

Another assertion by Mintzberg (1971) is that complexity in the business environment requires management skills in decision-making. Kahneman (2003), on the other hand, showed that intuition, particularly when estimating financial risks, is often a bad adviser. In other words, the theory about the rationality of the decision (classical model) shifts to the rationality of the decision-making process. This is in addition to the aforementioned complexity of investment decisions on sustainable innovations. In this context, the TRL system (such as the system developed by NASA, Heslop et al., 2001) recognises that marketing innovations require a series of decisions within which the investment decision can be distinguished.

Ellen MacArthur (2013) and her foundation demonstrate - in line with, for example, the Club of Rome's Meadows (1972) - the societal necessity and technological possibilities to achieve a more sustainable use of raw materials and resources and a so-called circular economy.

Attaining these results and reshaping production and consumption will require technological innovations, which often come with different organisational structures and partnerships.

Many authors, such as Jonker et al. (2017), link concepts such as new business models and multiple value creation to the implementation of the circular economy, or other concepts that express the need for new and complex economic models to make our societies more

sustainable. Authors such as Kahneman (2003) and previously Mintzberg (1971), on the other hand, emphasise the importance of clear and simple decision-making. And it becomes clear to indicate a contradiction between societal and economic sustainability: Van der Hoeven (2016) found no unequivocal Anglo-Saxon or Rhineland's entrepreneurial behaviour, and the declaration of the American Business Round Table (2019) has many Rhineland's aspects. All this leads to two major observations:

- I. In the case of investment decisions in sustainable innovations, it is important to have insight into the decision-making process;
- II. The rationality of decision-making and of the decision-making process is crucial for the effectiveness of investments in sustainable innovation.

These observations in turn lead to two research questions:

- I. Which criteria are crucial for the effectiveness of investments in sustainable innovation?
- II. In what way companies are dealing with these criteria?

### **Effectiveness criteria for investments in sustainable innovation**

In line with this, it is important first to look at criteria for modelling investment decisions in sustainable innovations in particular. In previous research based on case studies we were able to establish investment criteria to apply to sustainable innovations (Van der Hoeven & Bossert, 2019).

We showed that, in general, three traditional standards apply: the investments must fit within the core business, have a short payback time (a sufficient internal rate of return) and the company should be able to realise them independently. While investments in sustainable innovations often fail to meet these criteria, they still prove economically justifiable if five additional factors are considered: the possible societal benefits, potential value chain efficiency through cooperation, the mitigation of network uncertainties, financial responsiveness, and the personal contacts of the entrepreneur. These factors are summarized in Table 1.

**Table 1. Criteria for investments in sustainable innovations**

<b>Approach</b>	<b>Criteria</b>
Traditional standards	1. Fit within the core business
	2. Short payback time
	3. Stand alone / without a partner
Additional criteria for sustainable innovations	4. Societal benefits
	5. Value chain efficiency / external efficiency
	6. Mitigation of network uncertainties
	7. Financial responsiveness
	8. Personal contacts of the entrepreneur

Source: (Van der Hoeven & Bossert, 2019)

### **The SME practice with sustainable investments**

How are SME entrepreneurs dealing with this increasing complexity in practice? To find answers we studied cases of Dutch SME entrepreneurs when making investment decisions for sustainable innovations in practice. The aim of this research, therefore, is to determine how the traditional assessment criteria and additional criteria for sustainable innovations are implemented in the decision-making process and how entrepreneurs can be assisted with their investment decisions. The research is carried out through a series of case studies in a so-called knowledge workplace or living lab, comparable to The World Café method described by Ropes e.a. (2020). This way, the researchers will gain insight into the actual issues involved in this decision-making process regarding innovations, sustainable projects are encouraged and further assisted, and future professionals gain relevant experiences. In our research project, the assumptions are formulated as follows:

- Financing sustainable innovations, especially in SMEs, is difficult because of the need to convince external parties and the associated information asymmetry.
- A successful transition to a more sustainable economy but also the survival of companies requires more and more from the formal cooperation and financial skills. In particular, knowledge and experience with business economic aspects is not always top of mind within every company.

- The use of the necessary technical innovations requires more from companies than just applying traditional economic models. Concepts such as ‘new revenue models’, ‘multiple value creation’, etc. have to be brought into account and need to be translated into specific criteria.

The SME entrepreneurs in the research project that do invest in sustainable innovations are therefore not helped with just traditional investment decision concepts, but also need rationality in the decision-making process of investment decisions in the form of concrete criteria and insights into how this can be arranged. This involves a need for specific criteria and detailed step-by-step plans. The present research aims at validating the criteria previously found and to determine how these criteria affect the steps in the decision-making process. An investment checklist has drawn up for this purpose.

**Table 2. Aspects and focus points when investing**

Aspects	Focus points
1. Idea	<ul style="list-style-type: none"> <li>- Problem (what)</li> <li>- Solution (how)</li> <li>- Added value</li> </ul>
2. Market (who)	<ul style="list-style-type: none"> <li>- Customers</li> <li>- Launching customer</li> <li>- Competition</li> </ul>
3. External value creation	<ul style="list-style-type: none"> <li>- Where in the network</li> <li>- Societal</li> <li>- Earning capacities</li> </ul>
4. Budget / (foreseen) business model (value)	<ul style="list-style-type: none"> <li>- Exploitation</li> <li>- Liquidity</li> <li>- Investment</li> <li>- Financing</li> </ul>
5. People	<ul style="list-style-type: none"> <li>- Entrepreneur</li> <li>- Staff / team</li> <li>- Personal network</li> </ul>
6. Risk management	<ul style="list-style-type: none"> <li>- Risks</li> <li>- Mitigants</li> </ul>

Aspects	Focus points
7. Aimed financing form	<ul style="list-style-type: none"> <li>- Development phase</li> <li>- Needed investment amount</li> <li>- Potential forms financing</li> <li>- Potential financiers</li> </ul>

This investment checklist is based on previous research combined with general insights into business plans, revenue models and financing, as can be found in, for example, the publication of the Chamber of Commerce (2018). Gassmann et al. (2014) established how business models could be innovated based on experience and empiricism. De Koning (2012) was a senior SME account manager at Rabobank and did a graduate study in business administration at the EUR on this particular topic. Specific information about modern forms of financing, crowd funding and informal investors is derived from Oneplanetcrowd (2018) and Business Angels Networks Netherlands (Rikhof and Mulder, 2011).

This results in seven aspects and focus points that investors pay attention to. These are summarized in Table 2.

In order to arrive at a testable framework for the case studies, tables 1 and 2 are combined in table 3. For all assessment aspects, it was investigated how they correspond to testable effects in the assessment criteria. In this way the quality of the innovative idea is expressed in the societal benefits and the feasibility in the degree of consistency with the core competencies. The quality of the people is evident from the core competencies and the degree of independence, but also from their societal involvement and their handling of uncertainties, financiers and other external parties. See table 3. The table shows that if the classic criteria are met, this quickly leads to a convincing argument with regard to the investment. If the traditional criteria are not convincing, the substantiation of the business model and financing risk becomes a lot more complicated. The business case here can only be motivated using more than one particular perspective. And, where for many investments the factor people, the entrepreneur and his staff, are already decisive, the importance of this factor is strongly increasing in the case of sustainable innovations and the requirements are much higher.

**Table 3. Assessment framework for the case studies**

Aspects	Traditional criteria			Additional criteria for sustainable innovation				
	Core business	Pay back time	Stand alone	Societal return	External efficiency	Mitigation	Financial responsiveness	Personal contacts
Idea	*			*				
Market	*	*	*		*			
External values	*			*				
Business model	*	*	*		*			
People	*		*	*		*	*	*
Risk mngt		*	*			*	*	
Financing		*	*				*	*

Legend: \* aspect testable on the basis of the relevant criteria

### **Findings of the Dutch SME practice: towards multi-criteria decision-making**

As a follow-up to previous research and the theoretical comparison of focus points in sustainable innovations, the project investigated a sample of sixteen cases to discover the extent to which established criteria are problematic in practice. The researchers established this sample mainly because entrepreneurs and start-ups themselves, through incubators, requested examinations of their sustainable innovation business cases. The cases and the findings for each case can be found in table 4 (in the annex more characteristics of the cases can be found). In this table, an analysis is given for each case to what extent the innovation can be motivated on the basis of the various criteria, or whether its successful realisation depends on a certain criterion. For example, to combat food waste, the first idea fits within the core competencies of the company, but the direct financial return is poor (long payback period) and in any case requires cooperation. The idea clearly delivers societal benefits, and these can be cashed in through chain efficiency, but the realisation requires mitigation of uncertainties, financial responsiveness and contacts. The sixth plan, to switch to a hydrogen-powered canal boat, does not fit within the company's core competence, has a very poor financial return, and

is only motivated from a societal perspective. In order to turn it into an economically viable business case, financial contacts and insights are essential.

**Table 4. Findings on decision-making regarding sustainable investments**

Case characteristics	Traditional criteria			Additional criteria for sustainable innovation				
	Core business	Pay back time	Stand alone	Societal return	External efficiency	Mitigation	Financial responsiveness	Personal contacts
Combat food waste	++	-	--	+	+	+	+	+
Re-use buildings	+	-	+	0	+	+	+	0
Student housing	+	--	--	+	+	+	+	0
Tiny houses	+	-	--	+	0	+	+	+
Sustainable real estate	0	-	-	+	0	0	+	+
Hydrogen ship	--	--	+	++	0	0	+	+
Surfboard production	+	0	--	+	+	0	+	+
Energy calculation model	+	-	-	+	+	++	0	++
Energy saving	0	-	-	+	0	0	0	+
Local energy production	+	0	-	+	++	0	+	+
Solar park	+	-	+	+	0	+	+	+
Hydrogen tractor	0	--	-	++	+	+	+	+
Re-use food remains	+	0	-	+	+	+	+	+
Local food production	+	-	-	+	0	0	+	+

Case characteristics	Traditional criteria			Additional criteria for sustainable innovation				
	Core business	Pay back time	Stand alone	Societal return	External efficiency	Mitigation	Financial responsiveness	Personal contacts
Sustainable water transport	--	--	+	++	0	0	0	0
Recycling waste	+	0	-	++	+	0	++	++

Legend: 0 = neutral, + = positive, - = negative

The table shows that these cases, which have been selected for their contribution to sustainability, score poorly on the traditional assessment criteria. In particular, their financial return (payback time) is often insufficient, and they tend to require a potentially complex cooperation arrangement. Logically, they all offer societal benefits, and this motivates some in particular. However, that in itself is not a sufficiently convincing argument in all aspects of investment financing.

In some cases, these societal benefits can be translated into a more efficient value chain model through a formal cooperation concept, which usually requires safeguards against the uncertainties of that cooperation. The success of implementation almost always appears to depend on the relevant contacts and the financial responsiveness of the entrepreneur. Another finding regarding these cases was that those entrepreneurs in particular who are mainly guided by the pursuit of societal benefits were less interested in meeting the other assessment criteria of financing sustainable innovations. The study of previous cases came to the same conclusion.

Hence our prior assumptions are confirmed, that in order to turn sustainable innovations into commercial successes the entrepreneurs must explicitly be aware of the more difficult investment context. They have to know the requirements and have to express the added value of their innovation into financial terms that are the basis of their rational decision making process.

## Exploring the obstacles and facilitators

In the fall of 2019 and spring 2020 another study on twelve new cases (characteristics in annex) was performed. Hereby the lessons from the earlier cases explicitly were used to improve the preparation of the students who assisted entrepreneurs in translating their sustainable innovation idea into a financeable business model. This led to a validation of the previous finding in table 5.

**Table 5. Findings on decision-making regarding sustainable investments**

Case characteristics	Traditional criteria			Additional criteria for sustainable innovation				
	Core business	Pay back time	Stand alone	Societal return	External efficiency	Mitigation	Financial responsiveness	Personal contacts
Filtering ammonia	+	+	--	+	+	-	+	+
Local electricity storage	-	--	-	+	+	+	-	-
Energy production as a service	-	-	--	+	+	++	+	+
Energy saving in agriculture	-	--	-	+	+	+	+	-
Energy production by baffle boards	--	--	--	++	+	+	+	+
Test facility as a service	+	-	--	+	+	++	+	+
Modelling black-outs	-	-	--	+	-	++	-	+
Modelling off-grid facilities	-	-	--	+	-	+	+	-
H2 production on sea	+	--	--	++	+	+	-	+

Case characteristics	Traditional criteria			Additional criteria for sustainable innovation				
	Core business	Pay back time	Stand alone	Societal return	External efficiency	Mitigation	Financial responsiveness	Personal contacts
Wave energy	+	--	--	++	+	+	+	+
TCO clean streets	--	-	-	+	-	+	+	+
Efficient heat pump	-	-	--	+	+	-	-	+

Legend: 0 = neutral, + = positive, - = negative

In this more advanced prepared studies it was furthermore possible to explore in each case the principal obstacle in the business case development process and the main factor that could facilitate the success. These obstacles and facilitators are presented in table 6.

**Table 6. Observed obstacles and facilitators in eleven investment cases in sustainability**

Case study	Obstacle	Facilitator
Filtering ammonia	Complex regulation	Possible earnings
Local electricity storage	Complex regulation	Possible earnings
Energy production as a service	Customers don't like it	Possible efficiency gain
Energy saving in agriculture	Complex earning model	Bank loan
Energy production by baffle boards	Thin gains	Environmental advantage
Test facility as a service	Complexity	Possible efficiency gain
Modelling black-outs	No clear business model	Low costs
Modelling off-grid facilities	No clear business model	Low costs
H2 production on sea	Scaling up costs	Possible subsidies
Wave energy	Scaling up costs	Possible subsidies

Case study	Obstacle	Facilitator
TCO clean streets	No clear business model	Public interest
Efficient heat pump	Scaling up costs	Possible gains for end user

The outcomes of these exploratory case studies suggest the following preliminary conclusions regarding the external environment:

- Financial aspects are key for successful funding.
- Complexity is indeed an obstacle. Although an innovation may be economically feasible, it still often is hard to convince participants and investors. This has partly to do with the differences in language between technicians and economists.
- Governmental policy in the form of regulation and subsidies may be more of a burden than part of the solution since they sometimes tend to make the considerations even more complex than they are from them selves.

It therefore is advisable to involve economic analysis in an early development stage, so that the technical development is focused at potentially successful ideas rather than to elaborate first techniques in detail.

### **Conclusion and the consequences for the SME entrepreneur**

This research confirms earlier findings that implementing sustainable business models and financing sustainable innovations have proved to be more difficult than other types of investment decisions. However, it is certainly not impossible. The decision-making process is more complex than in the case of financing other types of innovations: it involves a wider range of diverse criteria, and these criteria entail connections with a variety of external parties. This becomes apparent both from a theoretical comparison of the focus points for financiers and from practice, through a systematic analysis of sixteen cases. The actual implementation of sustainable innovative ideas does place extra demands on management and organisations:

- The entrepreneur must have considerable knowledge and experience of the traditional business-economics approaches, supplemented with more complex calculation models, stacked financing and more complex cooperation models.
- Whether or not the investment in sustainable innovation will actually be realised depends to a large extent on the structure of the decision-making process.

- The rationality of the decision-making process determines the potential for arriving at a successful investment decision.
- Management must be aware of the importance of business goals and decision frameworks, which is not always self-evident for the entrepreneurs studied.
- This necessarily leads to a multi-criteria decision making process, where various technological, ecological and economical aspects are brought into account.
- And finally, the process is more demanding in terms of the personal networking skills of the entrepreneur, both in the relationship with chain partners and with financiers.

It is precisely in the case of investment and financing decisions that rational decision-making is preferable to intuition. And not every entrepreneur is equipped for this, especially given that the decision has to be made in a multi-criteria context. Training and coaching can provide more concrete support for SMEs in meeting these requirements on a number of points, but future entrepreneurs equally require greater awareness and updated training if they wish to achieve sustainability objectives.

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## Annex 1: Short case descriptions

### First sample

Case		
Combat food waste	start-up	advices restaurant to avoid spoiling food
Reuse buildings	new business model	extend lifecycle of offices
Student housing	new business model	availability of student exchange
Tiny houses	start-up	supply cheap circular livings
Sustainable real estate	start-up	develop sustainable communities
Hydrogen ship	existing business	fuel transition
Surfboard production	new business model	less waste in production
Energy calculation model	start-up	advisory for community policy
Energy saving	start-up	optimize energy efficiency in houses
Local energy production	start-up	development of energy systems
Solar park	new plant	production facility
Hydrogen tractor	start-up	development of city center tools
Reuse food remains	start-up	waste based food production and sales
Local food production	growing business	closing local loop
Sustainable water transport	existing business	energy transition
Recycling waste	new business model	upgrade waste based products

## Second sample

Case		
Filtering ammonia	new business proposition	avoid pollution
Local electricity storage	business development	energy transition
Energy production as a service	new business model	improve access sustainability
Energy saving in agriculture	existing business	energy saving
Energy production by baffle boards	start-up	energy transition municipality
Test facility as a service	new business model	improve access
Modelling black-outs	start-up	energy transition
Modelling off-grid facilities	start-up	energy transition
H2 production on sea	start-up	energy transition
Wave energy	start-up	energy transition
TCO clean streets	existing business	efficient municipality
Efficient heat pump	start up	energy transition