Decision-Support Framework for Dutch Primary School Building Renovation

To improve the People, Planet, Profit balance in renovated school buildings

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Abstract
International attention towards energy efficiency improvement is growing, pressuring the built environment to become more sustainable. Part of this energy efficiency improvement must be achieved at Dutch primary school buildings, but budget cuts on education complicate the development of sustainable school buildings. Subject to this financial pressure, the indoor environmental quality (IEQ) of Dutch primary school buildings is, and remains insufficient. This affects performance, productivity and health of students and staff, and additionally has monetary consequences for school boards. The inability to achieve healthy, energy efficient buildings is largely explained by a lack of knowledge and experience in building-renovation by many school boards. A decision-making framework is developed to provide school boards with knowledge, to better finance and organize renovation projects, providing more (financial) room to address the IEQ of their school buildings. Leading to more balanced school buildings in terms of People (IEQ), Planet (energy efficiency), and Profit (costs). This framework comprises of a decision flowchart, supplemented by sustainable measure packages, and are developed using desk research, qualitative interviews and expert meetings. Then tested by obtaining qualitative expectations in interviews and a focus group. Expectations are, that the decision-framework does provide more insight in the renovation decision-making process and opportunities. By raising problem awareness about indoor environmental quality effects, the framework is also expected to contribute to improved IEQ in renovated school buildings, improving the PPP-balance. For further development, elaboration of procurement and contracting, and digitalization of the designs is recommended. Furthermore, tests among 'eenpitters' (single school-school boards) are advised.

Keywords: Primary school buildings, Sustainability, Indoor Environmental Quality, Energy Efficiency, Decision Flowchart

Introduction

On "Earth Day", April 22nd, 2016, the Paris Agreement was open for signature (UN News Centre, 2016). Its aim is to (I) keep the global average temperature rise well below 2 °C, (II) increase the ability to adapt to the adverse impacts of climate change, and (III) adapt finance to the path that lowers greenhouse gas emissions and increases climate resiliency (UNFCCC., 2015).

On November 4th, 2016, the agreement became official international law (Fox News, 2016). For the European Union (EU), this strengthened the importance of their climate strategies and targets. Namely, the 2020 climate & energy package (EC, 2017a), the 2030 climate & energy framework (EC, 2017b), and the 2050 low-carbon economy roadmap (EC, 2017c). Their main targets are to bring down greenhouse gas (GHG) emissions by 20%, 40%, and 80% respectively.

Member states have committed themselves to the so-called '*20-20-20 targets'*, which includes the reduction of GHG emissions by 20%, increase of renewable energy to 20%, and increase of energy efficiency by 20% relative to 1990 (EC, 2011a). Of these targets, the energy efficiency target is furthest from being achieved. Prospects are that only half of the 20% reduction will be achieved (EC, 2011b), forcing member states to act.

The Dutch government composed strategies to comply with these binding EU targets. They are divided into sector specific strategies.

> *"The greatest energy saving potential lies in buildings"* (EC, 2011b, p.3).

The built environment accounts for 30% of the Dutch CO_2 emissions, therefore the '*Plan van Aanpak Energiebesparing Gebouwde Omgeving*' (Ministery of Internal Affairs, 2011) is created. This plan of action presents instruments as well as organizational- and financial measures that stimulate energy savings. Part of the energy efficiency improvement must be achieved in Dutch educational buildings.

Because of its complexity and poor state, this research focuses on Dutch primary education sector. The sector fails to improve the housing quality. The core issues identified in the Dutch educational housing sector are:

- International pressure to increase energy efficiency of school buildings,
- Increasing financial pressure due to budget cuts, in an already complex financing system,
- Poor indoor environmental climate in school buildings without the prospect of improvement, and
- Lack of knowledge and experience by most school boards in managing renovation projects and renovation opportunities.

It is expected that more knowledge and insight by school boards in technical, organizational and financing opportunities for renovation of school buildings leads to better organization and financing of renovation projects. Which in turn should lead to more financial space and attention towards the indoor environmental climate in renovation measures, resulting in school buildings with good PPP balance.

To determine whether the above statement stands, the following research question is formulated:

How can school boards take well-founded decisions about renovation of school buildings resulting in an improved People, Planet, and Profit balance?

Literature review

Little scientific research is conducted regarding the Dutch educational housing issues described above. This section discusses a range of key subjects that are covered in literature and reports. It presents a comprehensive overview of the current state of the Dutch primary educational housing sector.

What do we mean with sustainability?

Sustainability is a frequently used terminology. According to Johnston, Everard, Santillo, & Robèrt (2007) approximately three hundred definitions of sustainability or sustainable development exist. Therefore, this research requires a clear definition. This research follows the definition of sustainability by John Elkington (1994), who developed the triple bottom line theory, better known as the 3 P's: People, Planet, Profit. This definition indicates that sustainability is determined by the balance between these three P's.

In this research, the People dimension refers to the IEQ of primary school buildings, which influences health and performance of its occupants. The Planet dimension refers to the thermal energy performance of school buildings, and indirectly the damage inflicted on the Planet. The Profit dimension refers to the investment costs of making school buildings sustainable. Sustainability is the ultimate balance between these 3 P's, where the goals are to keep IEQ as high as possible, investment costs and energy demand as low as possible. Additionally, there are restrictions for each P, Such as legal boundaries and budget restrictions.

Primary education building stock

To create a sense of the magnitude of the Dutch primary education building task, some key figures are presented. According to a reference image of the Dutch utility sector (ECN, 2014b), 52% of the total building stock has a residential function, the utility sector accounts for 36% and the remaining 13% is overlapping. The utility sector consists of approximately 600 million m^2 GFA (gross floor area), of which 80% is used for the services sector. Primary education is estimated to account for 3% of the total number of buildings in the services sector (14,4 million m^2 GFA). Key figures

on the size of Dutch primary education are presented in Table 1.

Table 1 Key figures primary education (Stamos, 2017).

Primary education	
Total number of schools	6.985
Average floor area	1.300 m^2
Total number of students	1.546.000
Average number of students per school	224
Total number of school boards	1.085
- School boards with <10 schools	75%
- School boards with >10 schools	25%
Average number of schools per school board	6,4

Primary education energy use

ECN (2014a) estimate that primary school buildings in 2011 on average used 12.900 m^3 gas and 22.600 kWh electricity per year. The total gas use by the primary education sector in 2008 was estimated at 105,9 million m^3 and the total electricity use at 284,3 million kWh. The total gas use was 4 Petajoule (PJ), which accounts for 2% of the total energy use by all utility buildings. The total electricity use by primary schools was 1 PJ, which is 0,6% of the total energy use by all utility buildings. The total expenditures for gas add up to €72,7 million and electricity adds up to €53,2 million in total in 2008 (ECN, 2014a). On average, each school building thus spent almost €10.000 on gas and €8.000 on electricity in 2008.

Trends in primary education housing

At present, a maximum of 150 new school buildings are built every year (PO Raad, 2017a). The average lifespan of Dutch school buildings is estimated at 69 years (Algemene Rekenkamer, 2016). At the current construction rate, the average age of school buildings will increase further (RVO, 2014). The demand for primary education will decline in the period 2020, depending on location (Van Elp & Zuidema, 2013). Growth areas will experience less decline than shrinking regions. After 2020, the demand for primary education increases slightly. Influencing the building production and renovation. Currently, one-third of the building production (in m^2) consists of renovation projects. In the period till 2020, this will grow to half of the yearly building production, and will remain so after 2020. The growth in renovation is explained by the expected reduction in demand. For this expected growth in renovation demand, and because renovation should be preferred from an environmental perspective (Bueren, Bohemen, Itard, & Visscher, 2012), this research focuses on the renovation of school buildings, instead of new construction.

Financial pressure on education increases

On the first of June 2016, De Volkskrant published a list, in the corridors referred to as 'the menu', in which possible budget cuts are listed by the Ministry of Finance that together could save up to €50 billion (Glebels & Herderscheé, 2016). Part of this list are retractable education investments adding up to 350 million euros. Possible savings on primary education are presented of about €200 million. In September 2016, the Ministry of Education, Culture & Science (ECS) announced lump sum subsidy cutbacks adding up to €255 million of which the largest cutbacks will befall primary education, namely €70 million (De Algemene Onderwijsbond, 2016). These cutbacks will put pressure on the financial situation of primary schools and will inevitably be felt in the budgets for school buildings.

Indoor climate suffers

Inferior housing and budget overruns are the main problems in the building task of school boards according to Arkesteijn, Steijns, & De

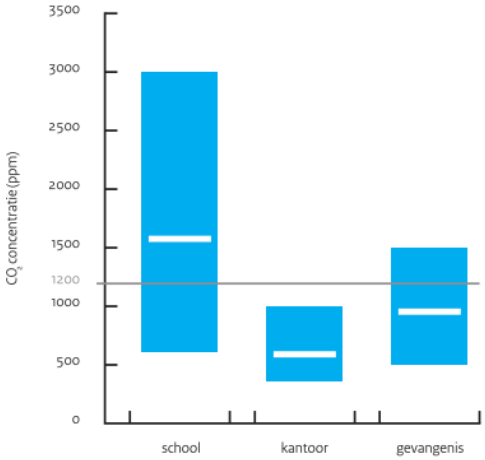

Figure 1 CO_2 concentrations (Boerstra, Haans, & Boerstra Binnenmilieu Advies, 2006)

Vries (2009). With new budget cuts in prospect, these problems could grow worse. One of the first things that suffers from budget cuts in education is the indoor climate (Rijksbouwmeester, 2009), for example leading due to the use of cheap materials in newly built school buildings or neglecting indoor climate measures (Heiltjes & Van Midden, 2008). Bad indoor climate affects the health, performance and productivity of occupants (P Wargocki, 2011). According to a survey by RVO (2015a) over 80% of school boards apply sustainability measures to school buildings to reduce energy costs or to improve the indoor climate. Yet the state of primary school buildings remains poor.

In 2015, RVO reported the situation in Dutch primary school buildings, the results are presented in Table 2. Figure 1 presents a comparison of CO_2 concentrations in schools, offices and prisons. CO_2 concentrations in schools appear much higher than in offices and prisons. Even highly sustainable school buildings appear to perform "not much better than schools based on more traditional designs" (Zeiler & De Waard, 2012).

Effects on health & performance

The indoor environmental quality of school buildings can affect health and performance of its occupants. Many researchers present proof of relations between IEQ on occupant health or performance:

Table 3 Research on relations between IEQ and health & performance

Relation	Research
Indoor temperature on performance	Mendell & Heath, 2005; Pawel Wargocki & Wyon, 2007
CO_2 concentration on performance	Myhrvold, Olsen, & Lauridsen, 1996; Shaughnessy, Haverinen-Shaughnessy, Nevalainen, & Moschandreas, 2006
Ventilation rate on performance	Pawel Wargocki & Wyon, 2007
CO_2 concentrations on health	Myhrvold et al., 1996

Sick Building Syndrome (SBS) "consists of a group of mucosal, skin, and general symptoms that are temporally related to working in particular buildings." (Burge, 1991, p. 1493). Studies indicate that health problems in schools are similar to the symptoms of SBS (Norbäck, Torgen, & Edling, 1990; Pegas et al., 2010). In offices, increased sick leave results from lower levels of outdoor air supply and IEQ complaints (Milton, Glencross, & Walters, 2000). An increased relative risk of 1.5-5 for respiratory illnesses and 1.1-6 for SBS symptoms are estimated for low ventilation rates compared to high ventilation rates (Seppänen, Fisk, & Mendell, 1999). This indicates the urgency to improve the educational building stock not only in terms of energy performance, but also in terms of IEQ.

Table 2 State of primary school buildings (RVO, 2015a).

Category	State	Share of the total number of schools
Insulation	Single glazing	31%
	Roof: not/poorly insulated	44%
	Façade: not/poorly insulated	41%
	Floor: not/poorly insulated	58%
Installations	Ventilation without heat recovery	89%
	Conventional boiler	11%
	Lighting – Conventional fluorescent lighting	61%
	Lighting – Lightbulbs	2%
Indoor environment	CO_2-concentration > 1200 ppm	80%
	Temperature summer > 25 °C	45%
	Too high dust concentration	35%
	Too high velocity (winter)	50%

Responsibilities in school building renewal

Municipalities are responsible for new construction of primary school buildings. They assign a portion of their budget to this purpose. After construction, municipalities remain economic owner of school buildings and school boards become legal owner (Van Elp & Zuidema, 2013). Exploitation of the buildings is the responsibility of school boards, for which they receive a lumpsum budget from the ministry of Education, Culture & Science (Ruimte-OK, 2014). They assign a portion for the maintenance and small improvements of the building. In the case of renovation, responsibilities are unclear. Neither of the parties are responsible in juridical or financial terms (PO Raad, 2017b). In practice, municipalities and school boards together discuss cost and responsibility allocation in renovation.

Lack of experience & knowledge by school boards in managing renovation projects

The core business of school boards is to provide high quality education, not the construction or renovation of school buildings. Generally, school boards set up a program of requirements for renovation. Depending on the arrangements, this task can be transferred to the municipality. Repeatedly, indoor environmental quality is neglected in this program of requirements (Rijksbouwmeester, 2009). This could lead to suboptimal sustainability solutions with too little emphasis on the People dimension. Besides the lack in building experience in general, sustainability is still a relatively new development concept, experiencing rapid new developments. Larger school boards are expected to gather more knowledge than small school boards.

School boards join themselves with the fact that they lack knowledge (Ruimte-OK & Klimaatverbond Nederland, 2015). They have insufficient insight in sustainable solutions for their buildings, accompanied by insufficient knowledge about financial opportunities and suspicion towards market parties. According to Ruimte-OK & Klimaatverbond Nederland (2015, p. 3) there are school boards that do not act because they describe themselves as "unconsciously incompetent" ("onbewust onbekwaam"), which does injustice to the renovation potential.

Both school boards and municipalities indicate financing of renovation projects as the major barrier to start renovation projects (Ruimte-OK & Klimaatverbond Nederland, 2015). Yet, there are plenty financing opportunities to facilitate school building renovation (Ruimte-OK, 2014; RVO, 2016). Ruimte-OK & Klimaatverbond Nederland (2015) questioned 135 school boards, of which 73% indicates that they do not possess sufficient knowledge of different financing forms. There is a large pool of knowledge regarding renovation opportunities, yet this knowledge is scattered and poorly coupled (Rijksbouwmeester, 2009).

Methodology

Several research methods are used to answer the research question. This section discusses what methods are applied and to what purpose. Furthermore, the decision framework developed in this research is introduced.

Desk research

The previous section presents desk research, introducing a solid foundation for this study. Through literature and reports the definition of sustainability for this specific research was defined, the state of the existing Dutch primary educational building stock was determined, legal boundaries are explored, the decision-making process was examined and the barriers and opportunities of sustainable renovation were determined.

Informative interview

As supplementary, an informative, qualitative interview with a member of a school board, and member of the PO-raad was conducted. This interview provided insights from practice that cannot be found in literature and reports. Such as the reasons for renovation and how the decision-making process works in practice. The interview was qualitative and semi-structured.

Design: Decision-support framework
The decision-support framework comprises of a decision flowchart and a set of technical measure packages.

Several sustainable measure packages or lists are developed by RVO, ECN and Arcadis. The packages by these institutions form a solid foundation, because these institutions have the necessary knowledge and networks to be progressive in this area of expertise.

Often, the focus of such packages is primarily on energy efficiency. The developed technical measure packages reflect on these existing measure packages, by:

- Determining useful aspects from the existing packages,
- Improving the attention towards IEQ, and
- Reflecting the measures against Dutch school building typologies.

Additionally, insight is provided in the effects of the measures on energy efficiency, IEQ, investment costs and payback period. This should provide school boards with insights in the effects of sustainability measures and guide towards school buildings with good balance between People, Planet & Profit.

The decision flowchart is "a graphical representation of the specific steps, or activities, of a process" (Fryman, 2001, p. 168). Flowcharts originate from computer programming in the 60's (Fryman, 2001), but are nowadays also applied business and government, e.g. in the form of decision flowcharts.

By presenting the considerations that need to be made in primary school building renovation, school boards are guided through the decision-making process, eventually leading to technical, financing and organizational opportunities. All the while, the effects of indoor environmental quality are addressed. With this design, sufficient information should be provided to support school boards in organizing and financing renovation, and trigger them to consider indoor environmental quality improvements.

Fryman (2001, p. 170) describes the following steps for constructing a flowchart:

1. Determine the process to be flowcharted
2. Determine the level of detail
3. Determine the process boundaries
4. List the beginning activity
5. List the sequential activities
6. List the ending activity

Although not in this exact sequence, these steps were taken in the development of the decision flowchart. The results from each step are presented in the results.

Expert meetings
Three expert meetings were organized to gain further knowledge from practice. The experts are key players in the Dutch primary educational housing sector from a.o. RVO, Ruimte-OK, Arcadis & BAM. Their expertise was used to gain insights in opportunities for school building renovation and to determine what considerations are or should be made by school boards in the decision-making process, which could be used in the development of the decision flowchart.

To gather the necessary information from these meetings, documents were prepared beforehand. Such as a list of themes to cover in the decision flowchart or a draft version of the flowchart. This enabled the attendees to focus their comments towards a final product.

Design testing
In a focus group, several market parties were brought together to test the workability and comprehensiveness of the designs. The attendees were selected based on their involvement and expertise in financing school building renovation. Also, some experts from the expert meetings attended. A focus group enabled the attendees to directly respond to each other's comments. Discussion among the attendees could instigate innovative ideas about the design and provide new opportunities.

Due to the period of this research, the design tests were during school holidays. The initial plan

was to also organize a work session among school boards as well, but this was not feasible given the holiday period. Therefore, qualitative and semi-structured interviews were held to receive input on the designs and the effects they might have.

Findings

The decision-support framework was presented to several school boards and financial experts. School boards were approached separately and reviewed the designs in semi-structured interviews. Financial experts were brought together in a focus group. With input from these experts, the framework was altered, and tested again by a school board member and a member of a municipality by ways of qualitative interviews. This chapter presents this process and itemizes the key findings from it.

Results from the focus group

In this focus group, the flowchart in Figure 3 was discussed. In general, the decision tree is in line with the vision of the NLII. They aim to create more demand for sustainability improvement in educational housing, to accelerate renewal of the existing building stock. Making school boards aware of the possibilities, the way this flowchart does, can contribute to this purpose. Regarding the structure and substance of the decision flowchart they gave useful comments that facilitated the finalization of the design.

Results from school board interviews

This section presents several subjects that were discussed in the interviews. Every subject concludes with an itemization of key findings. During these interviews, the flowchart in Figure 3 was discussed.

Way of- and reason for renovating

In general, school boards are in favour of renovation. In the Netherlands, schools have approximately a third extra space compared to legal standards. They want to keep this, which can only be done through renovation. But lack of structure and clarity in legislation about renovation responsibilities is a real problem. The administrative complexity on both the side of the schools as the municipality is underestimated. The knowledge about educational housing in municipalities is also disappearing. Making it difficult for school boards to find someone to talk to. Therefore, in practice, school boards target new construction, because then responsibilities are clear.

- Renovation is preferred by school boards, yet unclear responsibilities complicate renovation.
- Large scale one-off renovation is sometimes preferred above stepwise renovation, unless it includes quick wins.

The fact that school boards prefer renovation, is a sign that school boards would be interested in the opportunities of renovation. The sustainable measure packages facilitate both large scale, one-off renovation as well as quick wins.

Knowledge level on renovation of school buildings

Educational housing is often something boards do alongside their core activities, making it difficult to develop knowledge and experience. Within municipalities, knowledge and experience is disappearing. Therefore, knowledge of advisors is important. Yet for school boards it is difficult to judge the knowledge of advisors, for this they should use means presented by agencies like Ruimte-OK and the Green Deal Scholen.

Many forget that school board members are people who in most cases started as teacher, and after training worked their way up to school management and eventually to the board. Lack of knowledge, problem awareness, and power to get to solutions are indicated as main problems in educational housing, instead of financing. Money is not always the problem. E.g. Heerhugowaard is a small municipality with little funds, but has always been a leader in sustainability. This was because they got subsidies from e.g. the EU and the Waddenfonds (2017). The question "how bad do you want it?", is important as it determines how much effort is put in finding the right solutions and partners and gaining knowledge.

- The interviewees possess much knowledge, but for the average school board this is not the case.

- Lack of knowledge is one of the main issue in educational housing.

The designs can provide a basic level of knowledge, partly tackling this issue.

Decision flowchart

The flowchart provides useful guidance and recognizable considerations. E.g. the building periods develop an image about what buildings they include. Also, the financial opportunities are recognizable, mostly from presentations by Ruimte-OK and other institutions. School boards can be reserved about these opportunities. Partly because they have sufficient reserves to finance renovation, and partly because schools need the municipality and warranties for such means. If a school board does not have much inhouse knowledge, this flowchart is very interesting. It would be useful to look at it together with the municipality, as they are often critical in making decisions.

The framework should use existing instruments, as there already exist so many. The framework should help simplify things and help make decision. In the consideration, what to do with a building, this framework is useful. As there is a lot on this area, and this is simple enough, especially if it can be made digital. It will make school boards curious. It will not answer all questions, but will be useful in making considerations, broadening view, and equipping and preparing school boards in conversations with advisors and contractors.

Some school boards are rather sceptic about many of the financial and organizational opportunities. They often have only few success stories. And in practice many stakeholders are involved (multiple municipalities, school board, market parties), which puts up so much time and effort, that nothing comes of it, while the ideas are very promising in theory.

If a school board has a project at hand, and a tool for which little knowledge is necessary and several logical steps are followed, from which a general advice results, can provide useful insights. Its simplicity is its strength. The flowchart is especially helpful for so called 'eenpitters', which entails almost half of all Dutch primary school boards (PO-Raad, 2010), and during the initiation phase. 'Eenpitters' are school boards managing a single school.

The decision flowchart somewhat fails in speaking the same language as school boards. Their business evolves around the quality of education. School boards need to be aware of the effect that their buildings have on the quality of education. Using this as starting point can evoke problem awareness. Furthermore, school boards generally reason from portfolio level, starting with the strategic housing policy. Also, it was advised to work from a Total Cost of Ownership (TCO)-approach. Because this provides opportunities for a long-term vision. Finally, procurement is an important aspect. School boards are no experienced principals. If they would procure based on lowest price, the results could be bad. They should procure performance-based, this way they challenge the market to come with smart solutions.

The decision flowchart can also be an eye-opener for 'eenpitters', by showing them that they need to scale up. The flowchart is 'interesting', but needs further development in using 'education language' by focusing on the quality of education.

- School boards can be skeptic about the workability of the opportunities, possibly due to the lack of trust towards market parties.
- The decision flowchart should use more 'education language' and a TCO-approach.
    - A TCO-approach is not always applicable in primary educational housing. It is very dependent on the organization, E.g. it is applicable in case of 'volledige doordecentralisatie'.
- Its simplicity makes the flowchart useful, especially for 'eenpitters'.
- The flowchart provides a basic knowledge level for talks with market parties.

These expectations show that the designs can provide additional knowledge. Yet the scepticism by school boards towards some of the opportunities is another hurdle. Additional information, presenting comparisons between the opportunities as discussed in the focus group, could take away this scepticism partly. Using 'educational language' is a good take-away.

Indoor Environmental Quality
The flowchart presents recognizable definitions such as energy labels and Frisse Scholen Klassen. This helps to understand what IEQ is about. In the end, it explains why IEQ is important and that it improves learning performance.

From experience, two issues are apparent: IEQ needs to be supervised from above (by school boards), because bottom up initiatives will not come and operable windows are important for psychological effect.

Not everyone is aware of the importance of IEQ. It is therefore important to emphasize this. The students themselves do not care for the IEQ, but they are still entitled to a healthy learning environment. IEQ should be promoted to municipalities and school boards and nationwide to parents and teachers to make them aware of the consequences.

The experts underline that IEQ is a very important, underestimated subject. Partly because end-users, teachers and students, often do not experience the IEQ as bad. Also, the effect of behaviour on the IEQ is largely unknown and underestimated. The fact that school boards would do anything to improve the quality of education, needs to be used to create awareness of IEQ. The perception on quality of a school building by school boards is currently only coupled to the marketing value of their buildings: a good building attracts more students.

- The flowchart presents useful, important insights in the effects of IEQ.
- The insights in IEQ help create problem awareness by school boards, which is currently an underestimated subject.

The attention to IEQ is appreciated by school boards and can guide them towards school buildings with better IEQ.

Conclusion
The flowchart is in line with the way school boards look at renovation. It provides ways to make renovation possible. It also presents ways to tackle the building in one go.

The knowledge level of school boards is deemed poor by the interviewees and even perceived as the core issue in educational housing. This is in line with the goal of the decision flowchart to improve knowledge and insight. Using more 'education language' and a TCO-approach could improve the flowchart. Yet, a TCO-approach depends on the organizational structure of the housing responsibilities, and is therefore not always applicable. 'Education language' could be incorporated more. The implementation of IEQ is important and helps to create problem awareness.

Discussion
This section presents the adjustments that followed from the findings presented above. Many small adjustments are made with respect to the reviewed framework. Only the major adjustments are discussed here. After these adjustments, this framework (Figure 4) is again tested by a school board member and a member of a municipality through semi-structured interviews. This enabled an additional review upon this latest version of the framework.

Package formulation
The technical packages are formulated differently. The 'Basis' package is changed to 'Wettelijk minimum'. This way it is instantly clear what the package is about and for what sustainability ambition. The 'Energiezuinig, kostenefficient & energiezuinig' package did receive positive feedback. But it does not present how energy-efficient, cost-efficient and healthy it is. Therefore, the name of this package is changed in 'Energielabel C & Frisse Scholen B/C'. The third package, 'energieneutraal', tried to emphasize the ambitious character of this

package. Yet, whether the package results in an energy neutral school building, cannot be ensured. Therefore, and to enable comparison with the second package, the name is changed to 'Energielabel B & Frisse Scholen B/C'.

Portfolio level
The top half only enabled the application of one school building, while the bottom half can be used for a portfolio of buildings. To smoothen this out, the top half needs to become applicable for portfolios. The new framework presents a question ending the top half, asking whether the school board wants to improve a single building, or a building portfolio. In case of one building, the flowchart can be followed as before, in case of a portfolio, the top half can be repeated for every building in the portfolio.

From informative to decisive
In the previous version, the bottom half did not provide guidance in the selection between financing and organizational opportunities. Therefore, this part is provided with additional considerations, guiding school boards through the decision-making process.

Differentiation between funding, financing and organization
The focus group indicates that the way funding, financing and organization of projects is applied is unstructured. This new framework tries to structure these different opportunities. First, funding opportunities are presented by ways of own means and municipal funds. If these are insufficient, third party financing options are presented. The organizational opportunities are presented after.

Additional framework review
These final tests are conducted with a member of a school board and a municipality. Again, semi-structured interviews determined the workability of the framework and the qualitative expectations on the People, Planet, Profit balance in renovated school buildings. During these interviews, the flowchart in Figure 4 was discussed.

Sufficient knowledge is present at the major Dutch school boards, but this is not the case for smaller school boards. Also, municipalities experience a lack of knowledge.

In case of renovation, mandatory and extra sustainability measures can be distinguished. For the latter, the focus is on measures that are earned back in 10-15 years, for two reasons: first, because installations generally have a depreciation period of 10-15 years, then renewal is necessary. The depreciation periods should be added to the measure packages. Second, because of technical developments in the market. School boards want to apply the state-of-the-art installations. If you take measures with a longer payback period, you anticipate for an aging building.

The general response is positive about the Decision Flowchart. The building periods are recognizable. Furthermore, school boards can organize renovation projects better with the knowledge this flowchart provides. Additionally, this could also have a positive effect on the IEQ in the renovated school buildings.

The flowchart misses a question that stipulates who is responsible for the quality of the school buildings. This should be clear, as well as the sustainability ambition for the school building. Then, it becomes easier to determine how much funds should be brought in by the municipality. This way, the flowchart can also facilitate in the talks with the municipality. The question; who is 'bouwheer', becomes less relevant, because the quality is stipulated.

Furthermore, the traditional procurement method is generally applied. It is assumed that the innovative ways of organizing are not feasible, especially for small school boards. The traditional method is simple, and therefore better.

In the technical measure packages, a BENG alternative is missed. If the flowchart is to be used for a longer period, the BENG option is important, because by 2040/50 BENG will be mandatory for existing buildings. If the life-time

of a building is prolonged by 25 years in the coming years, it will still exist after 2040 and possibly subject to BENG-demands.

The BENG-demands for school buildings are:

- Energy demand of max. 50 kWh/m^2/year
- Primary fossil energy use of max. 60 kWh/m^2/year
- A renewable energy share of min. 50%

These demands are less specific than the Frisse Scholen demands. Therefore, it is more complicated to provide a generic indication of measures, with substantiated assumptions.

The way this flowchart copes with portfolios is less useful for large portfolios. With a portfolio of 150 schools, it is quite a job to repeat the top part 150 times. This is only possible for medium-, and small-sized school boards.

Finally, more guidance can be given in the way funds are distributed between the municipality and school boards. The measures in the 'Wettelijk minimum'-packages, are energy-saving measures and can be added to the MJOP of a school board. This means that these measures are paid from their own reserves, or the lump sum subsidy. If the measures aim at lifetime extension of the building, municipalities are also responsible. The rule of thumb for funding responsibilities in case of renovation is (Table 4):

Table 4 Responsibilities in renovation (rule of thumb)

Funding goal	Responsible
Energy efficiency	School
IEQ improvement	Municipality
Lifetime extension	Municipality
Building flexibility	Negotiable

This distinction can be included in the decision flowchart, as it provides a basis for discussion between school boards and municipalities. It can help school boards in making municipal funds available for renovation.

Design finalization

Following these final design tests, the design is finalized into the flowchart in Figure 5. The quick wins should be grouped under maintenance (MJOP), which are funded by the party who takes the financial risks. This can be the school, the beheerstichting or a third party (ESCo). This question is added to the flowchart. In case of renovation the funds are delivered by the school board and municipality together. The 'rule of thumb' can be used here, and is therefore added in the Legend. Borrowing is grouped under 'own means', because the loan is paid off with the lump sum subsidy received from the ministry of Education, Culture & Science.

After this, market party selection starts, where the choice can be made between traditional procurement or innovative procurement. The latter guides towards organizational opportunities.

The 'Nul-op-de-meter'-package and the NLII-initiative are removed for the time being, because these instruments are not available yet.

Conclusions

The decision-making process in school building renovation is very dynamic and cluttered. In general, many discussions with the municipality precede any decision regarding renovation. Key issue in most of these discussions is financing: what measures are necessary to take? What is the necessary budget? And who is going to fund which part of the renovation? For this reason, the respondents often indicated that the flowchart should begin with the ’financing part’. Yet, beginning with the ’finance part’ can limit their sustainability ambition, because school boards generally prefer funding with their reserves, limiting the budget. If they first state their ambitions, these are less restricted by budget. Then presenting ways to meet their ambitions can commit them to these ambitions, making them more willing to change their view regarding external financing. The respondents could find themselves in this explanation. In general, the respondents agreed with the general structure of the flowchart.

The respondents were positive about the way the flowchart presents an overview of available opportunities. Even though, some were sceptic about some of the more innovative

organizational forms, it does inform them of the opportunities that are at hand, and their benefits. Although most respondents are aware of the available opportunities, because they are experts in the educational housing market, they indicate that in general the level of knowledge about renovation opportunities is insufficient. Thus, the insight in renovation opportunities is very useful for the average school board, who does not have the capacity to hire a housing expert. The respondents expect that the flowchart helps ease the organization and financing of renovation projects.

The attention the flowchart presents on the effects of indoor environmental quality on the quality of education, is regarded as a valuable addition to the flowchart. It evokes necessary problem awareness, which is currently an underestimated aspect in school building renovation. Respondents expect that the focus on indoor environmental quality can increase the attention to the indoor environment in the renovation of school buildings.

The increase in problem awareness and attention to indoor environmental quality, could lead to more balanced renovations in terms of People, Planet & Profit, as the importance of the People dimension is emphasized and recognized. The Planet dimension, or energy performance, will remain important due to (inter)national pressure to improve energy efficiency. Also, the Profit dimension will remain important given the complicated financing structure. Whether the decision flowchart can increase the financial room available for indoor environmental quality improvement is dependent on the willingness of school boards to abandon their current views on funding and financing and to engage in more innovative ways of organization and financing. Additionally, the market should find ways to speed up the development and learning curve of these innovative opportunities, making them more trustworthy.

Recommendations

The interviewees recognized the added value of the decision flowchart. Also, the attention to indoor environmental quality is appreciated and supported. The outcomes of this research are limited to qualitative expectations, and present a first indication of the added value renovation knowledge can have in improving the balance between People, Planet & Profit. To further substantiate these expectations, quantitative effects can be researched using e.g. case studies. In these case studies, school boards who have recently performed a renovation, can apply the flowchart these renovated school buildings. The effects of the technical measure packages that result from the flowchart can be determined mathematically using thermal energy balance calculations, and can be compared with the executed renovation. Also, the financing outcomes can be compared with the executed renovation. By determining the Total Cost of Ownership, the financial situations can be compared.

Apart from the effects of indoor environmental quality on health, productivity and performance, little scientific research is conducted regarding school building renovation. Especially the relationship between knowledge by school boards and the consideration of the People, Planet & Profit dimensions has not been researched to date. In this area, this research is the first in its form and can be built upon to further improve the Dutch primary educational housing stock.

This scientific research, with a practice-oriented character, presents an elaborate overview of the existing situation in the Dutch educational housing sector and identifies several issues. By presenting the decision-making process in combination with renovation opportunities, the decision flowchart aims to support the renovation decision-making process by providing knowledge.

To further improve the Dutch primary school building stock, this research contributes to a better work & learning environment for staff and students. With better indoor environmental quality, their performance, productivity and health improves. Additionally, this can have

direct and indirect monetary effects. Directly through e.g. sick leave, or indirectly through higher income in the adult life of students.

But, a lack of problem awareness is apparent. Not only at school boards, but also student and their parents. Improving the awareness of the effects that school buildings have on performance, productivity and health, could lead to more attention to IEQ improvement. Through the participation council, parents can influence school boards in the development of school buildings with proper indoor environmental quality.

As this decision-support framework mainly focuses on school boards, parents are less involved. Awareness of parents can be awakened through general media, social media or education oriented organizations such as Ruimte-OK or PO Raad.

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Legenda

Introductie
Deze beslisboom dient als handvat in het besluitvormingstraject rond de verduurzaming van schoolgebouwen. De uitkomsten bieden slechts een indicatie in oplossingsrichtingen. Om vervolgstappen te nemen ter verduurzaming van uw schoolgebouw, wordt aangeraden een adviseur te raadplegen om het advies verder te specificeren voor uw situatie.

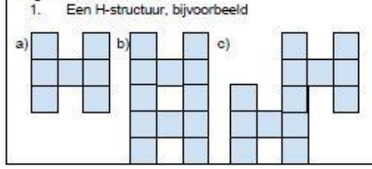
Ter informatie
Het energielabel is een bouwkundige bepaling van de energiezuinigheid van een gebouw. Dit is afhankelijk de energieprestaties van het gebouw en de installaties. Het energielabel staat los van het werkelijke elektriciteits- en gasverbruik. Dit is afhankelijk van het gebruik, beheer en onderhoud van gebouw en installaties.
In de wet milieubeheer staat een reeks maatregelen, die verplicht zijn voor scholen met een elektriciteitsverbruik van meer dan 50.000 kW en een gasverbruik van meer dan 25.000 m^3. Dit biedt geen garanties m.b.t. energielabels en elektriciteits- en gasverbruik.

Toelichting bouwperiodes
De keuze voor de bouwperiodes komt voort uit de bouwtypologieën van schoolgebouwen uit de desbetreffende bouwperiode (ECN).
- Vóór 1975 (Energielabel G)
Weinig tot geen aandacht voor koudebruggen, slechte isolatie, natuurlijke ventilatie en enkel glas.
- Tussen 1975 en 1992 (Energielabel F & E)
Opkomst aandacht voor koudebruggen, invoering nieuwe NEN-normen. Verbeterde isolatie, mechanische afvoerventilatie, invoering dubbel glas en HR ketels.
- Na 1992 (Energielabel <D)
Invoering bouwbesluit. Verbeterde isolatie, invoering mechanische toe- en afvoer en veegpulsschakeling verlichting.

Toelichting ambitieniveaus maatregelpakketten
Er zijn maatregelpakketten geformuleerd aan de hand van drie ambitieniveaus:
1. Basis
   De Basispakketten bestaan uit een selectie van de erkende maatregelen uit het Activiteitenbesluit Milieubeheer. Deze maatregelen zijn binnen 5 jaar terugverdiend.
2. Energiezuinig, kostenefficiënt & gezond
   Deze pakketten richten zich op het behalen van Bijna Energieneutrale Gebouwen (BENG) .Deze maatregelen zijn binnen 20 jaar terugverdiend.
3. Energieneutraal & gezond
   Deze pakketten richten zich op het behalen van energieneutrale scholen.. Het duurt ongeveer 25 jaar om deze maatregelen terug te verdienen.
4. Nul-op-de-Meter
   Dit pakket richt zich op het behalen van Nul-op-de-Meter scholen en is enkel toepasbaar op MuWi-systeem scholen. Het duurt ongeveer 25 jaar om deze maatregelen terug te verdienen.

Toelichting ESCo's
Energie Service Companies (ESCo's) zijn onderhoudsbureaus of installateurs, die de installatie, het onderhoud en/of het beheer van installaties verzorgen. De investeringskosten komen voor rekening van de ESCo, die daarnaast energiebesparing garanties geeft (in een energieprestatiecontract). Schoolbesturen betalen de financieringslasten met rente terug.

Toelichting systeem scholen
Het gebouw betreft een MuWi-systeem school indien het de volgende kenmerken heeft:
1. Een H-structuur, bijvoorbeeld



Wat is het bouwjaar van het gebouw?

<1975

Wat is de horizon van de beoogde ingreep?

±5 jaar

±15 jaar

±25 jaar

Betreft het een systeem school?[1]

Nee

Ja

Wat is het ambitieniveau van de beoogde ingreep?

Basis

Energiezuinig, kostenefficiënt & gezond

Energieneutraal

Nul-op-de-Meter

Wist je dat?!
Productiviteit kan tot 23% verbeteren door beter licht en 1% door verbeterde ventilatie.
(EC Harris)

1975-1992

Wat is de horizon van de beoogde ingreep?

±5 jaar

±15 jaar

±25 jaar

Wat is het ambitieniveau van de beoogde ingreep?

Basis

Energiezuinig, kostenefficiënt & gezond

Energieneutraal

Wist je dat?!
10% productiviteitsverhoging kan de volledige installatie en exploitatiekosten van een gebouw compenseren.
(Wargocki, 2011)

>1992

Wat is de horizon van de beoogde ingreep?

±5 jaar

±15 jaar

±25 jaar

Wat is het ambitieniveau van de beoogde ingreep?

Basis

Energiezuinig, kostenefficiënt & gezond

Energieneutraal

Hoe kan dit bekostigd worden?

Eigen middelen

Gemeentelijke middelen

Lenen

Onderhoudsbureau / Installateur (ESCo's)

Innovatieve organisatievormen

Wat is de omvang van de opdracht?

<€10.000.000

>€10.000.000

Schatkistbankieren

Bundeling & Projectfinanciering

BNG & Commerciële banken

Fiscale voordelen: EIA, MIA, VAMIL

[2] Beheersstichting/ cooperatiemodel Sale & lease back (SMV) Samenwerking met andere marktpartijen

Wist je dat?!
Studenten scoren 5-14% hoger op tests en leren 20-26% sneller dankzij verbeterde verlichting.
(EC Harris)

Wist je dat?!
De gemiddelde energiekosten van een schoolbestuur zijn ±1,2% van de totale kosten, personeel en vervangingskosten ±80%. 2% verhoging van personeelskosten wegens slecht binnenklimaat representeert 1.6% van de totale kosten. 46% besparing op gas en 33% op elektriciteit, representeert slechts 0,6% van de totale kosten.
(Zeiler & Boxem, 2009)

Wist je dat?!
1% productiviteitsverbetering kan leiden tot 1% prestatieverbetering, wat op zijn beurt de effectieve werktijd per dag met 5 minuten verlengt, ziekteverzuim met 2 dagen per jaar vermindert en de jaarlijkse ventilatie kosten compenseert.
(Wargocki, 2011)

ISDE subsidieregeling
Schoolbesturen kunnen een tegemoetkoming aanvragen voor de aanschaf van:
Subsidie vanaf:

- Zonneboilers	< 200 m^2	€ 500,-
- Warmtepompen	< 70 kW	€ 500,-
- Biomassaketels	< 500 kW	€ 3.200,-
- Palletketels		€ 500,-

(afhankelijk van het soort apparaat)

[2] **Innovatieve oplossingen**
- Beheerstichting of Coöperatiemodel
  Schoolgebouw wordt ondergebracht in een stichting, waar schoolbesturen eigenaar van zijn. Integrale verantwoordelijkheid huisvesting en financiering, schaalvoordelen. Bij een coöperatiemodel blijft het gebouw eigendom van het schoolbestuur.
- Sale & leaseback (SMV)
  Het schoolbestuur draagt het eigendom over aan een aparte stichting, waaruit schoolbesturen het gebouw huren. Dit biedt de mogelijkheid tot TCO benadering. Verduurzaming wordt de verantwoordelijkheid van de stichting.
- Samenwerking met marktpartijen
  Dit draait om het slimmer huisvesten van het gebouw. Hier kunnen samenwerkingen worden aangegaan om het gebouw efficiënter te gebruiken.

Figure 2 Decision flowchart used in Focus group and first interviews (Aalberts, 2017; Piet, 2017)

Legenda

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De beslisboom richt zich enkel op de renovatie van bestaande schoolgebouwen.
In de technische oplossingen wordt Frisse Scholen Klasse A niet als ambitie bijgevoegd, omdat dit uit het oogpunt van kostenefficiëntie niet realistisch is voor bestaande gebouwen.
De denkwolkjes bieden inzicht in de effecten van het binnenmilieu in schoolgebouwen op de onderwijskwaliteit en prestaties van leerlingen en leraren.

Ter informatie
Het energielabel is een bouwkundige bepaling van de energiezuinigheid van een gebouw. Dit is afhankelijk de energieprestaties van het gebouw en de installaties. Het energielabel staat los van het werkelijke elektriciteits- en gasverbruik. Dit is afhankelijk van het gebruik, beheer en onderhoud van gebouw en installaties.
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- Na 1992 (Energielabel <D)

Invoering bouwbesluit. Verbeterde isolatie, invoering mechanische toe- en afvoer en veegpulsschakeling verlichting.

Toelichting ambitieniveaus maatregelpakketten
Er zijn maatregelpakketten geformuleerd aan de hand van drie ambitieniveaus:
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   De Basispakketten bestaan uit een selectie van de erkende maatregelen uit het Activiteitenbesluit Milieubeheer. Deze maatregelen zijn binnen 5 jaar terugverdiend.
2. Energielabel C & Frisse Scholen B
   Deze pakketten bieden perspectief voor de toekomstige Energielabel C verplichting. Deze maatregelen zijn binnen 20 jaar terugverdiend.
3. Energielabel B & Frisse Scholen B(/C)
   Deze pakketten richten zich op het behalen van Energielabel B. Het duurt ongeveer 25 jaar om deze maatregelen terug te verdienen.

(4.) Nul-op-de-Meter
Dit pakket richt zich op het behalen van Nul-op-de-Meter scholen en is enkel toepasbaar op MuWi-systeem scholen. Het duurt ongeveer 25 jaar om deze maatregelen terug te verdienen.

ISDE subsidieregeling
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Footnotes
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Het gebouw betreft een MuWi-systeem school indien het de volgende kenmerken heeft:
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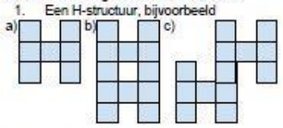

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- NLII initiatief
  ...
- Coöperatiemodel
  Bij een coöperatiemodel zijn de schoolbesturen eigenaar van een stichting waar de onderwijsgebouwen worden ondergebracht. Integrale verantwoordelijkheid huisvesting en financiering, schaalvoordelen.
- Beheerstichting
  Schoolgebouw wordt ondergebracht in een stichting, waar een derde partij eigenaar van is. Dit biedt de mogelijkheid tot een TCO benadering en schaalvoordelen.
- Sale & leaseback (SMV)
  Het schoolbestuur draagt het eigendom over aan een aparte stichting, waaruit schoolbesturen het gebouw huren. Dit biedt de mogelijkheid tot TCO benadering. Verduurzaming wordt de verantwoordelijkheid van de stichting.

Figure 3 Decision flowchart used in last interviews (Broekhuis, 2017; Den Outer, 2017)

Duurzame Beslisboom

Voor de renovatie van bestaande schoolgebouwen

Toelichting
Deze beslisboom dient als handvat in het besluitvormingstraject rond de verduurzaming van schoolgebouwen. De uitkomsten bieden slechts een indicatie in oplossingsrichtingen. Om vervolgstappen te nemen ter verduurzaming van uw schoolgebouwen, wordt aangeraden een adviseur te raadplegen om het advies verder te specificeren voor uw situatie.
De beslisboom richt zich enkel op de renovatie van bestaande schoolgebouwen.
In de technische oplossingen wordt Frisse Scholen Klasse A niet als ambitie bijgevoegd, omdat dit uit het oogpunt van kostenefficiëntie niet realistisch is voor bestaande schoolgebouwen.
De denkwolkjes bieden inzicht in de effecten van het binnenmilieu in schoolgebouwen op de onderwijskwaliteit en prestaties van leerlingen en leraren.
In de wet milieubeheer staat een reeks maatregelen, die verplicht zijn voor scholen met een elektriciteitsverbruik van meer dan 50.000 kW en een gasverbruik van meer dan 25.000 m^3. Dit biedt geen garanties m.b.t. energielabels en elektriciteits- en gasverbruik.

Toelichting bouwperiodes
De keuze voor de bouwperiodes komt voort uit de bouwtypologieën van schoolgebouwen uit de desbetreffende bouwperiode, gebaseerd op bouwregelgeving en -normen (ECN).

- Vóór 1975 (Energielabel G). Weinig tot geen aandacht voor koudebruggen, slechte isolatie, natuurlijke ventilatie en enkel glas.
- Tussen 1975 en 1992 (Energielabel F & E). Opkomst aandacht voor koudebruggen, invoering nieuwe NEN-normen. Verbeterde isolatie, mechanische afvoerventilatie, invoering dubbel glas en HR ketels.
- Na 1992 (Energielabel <D). Verbeterde isolatie, invoering mechanische toe- en afvoer en veegpulsschakeling verlichting.

Toelichting ambitieniveaus maatregelpakketten
Er zijn maatregelpakketten geformuleerd aan de hand van drie ambitieniveaus:

1. Wettelijk minimum

De Basispakketten bestaan uit een selectie van de erkende maatregelen uit het Activiteitenbesluit Milieubeheer. Deze maatregelen zijn binnen 5 jaar terugverdiend. Daarnaast worden in het Bouwbesluit eisen gesteld. In geval van de oudste gebouwen, kan met een terugverdientijd van 5 jaar niet aan het bouwbesluit worden voldaan.

2. Energieklasse C & Binnenklimaat B

Deze pakketten richten zich op het behalen van Energieklasse C. Deze maatregelen zijn binnen 20 jaar terugverdiend.

3. Energieklasse B & Binnenklimaat B(/C)

Deze pakketten richten zich op het behalen van Energieklasse B. Het duurt ongeveer 25 jaar om deze maatregelen terug te verdienen.

Innovatieve oplossingen

- Onderhoudsbureaus (ESCo's)

Energie Service Companies (ESCo's) zijn onderhoudsbureaus of installateurs, die de installatie, het onderhoud en/of het beheer van installaties verzorgen. De investeringskosten komen voor rekening van de ESCo, die daarnaast energiebesparing garanties geeft (in een energieprestatiecontract). Schoolbesturen betalen de financieringslasten met rente terug.

- Coöperatiemodel

Bij een coöperatiemodel zijn de schoolbesturen eigenaar van een stichting waar de onderwijsgebouwen worden ondergebracht. Integrale verantwoordelijkheid huisvesting en financiering, schaalvoordelen.

- Beheerstichting

Schoolgebouw wordt ondergebracht in een stichting, waar een derde partij eigenaar van is. Dit biedt de mogelijkheid tot een TCO benadering en schaalvoordelen.

- Sale & leaseback (SMV)

Het schoolbestuur draagt het eigendom over aan een aparte stichting, waaruit schoolbesturen het gebouw huren. Dit biedt de mogelijkheid tot TCO benadering. Verduurzaming wordt de verantwoordelijkheid van de stichting.

Vuistregel: *Wie is verantwoordelijk voor welke aanpassing?*

Levensduurverlenging	Gemeente
Energie	Schoolbestuur
Binnenklimaat	Gemeente
Flexibiliteit	Discutabel (school/gemeente)

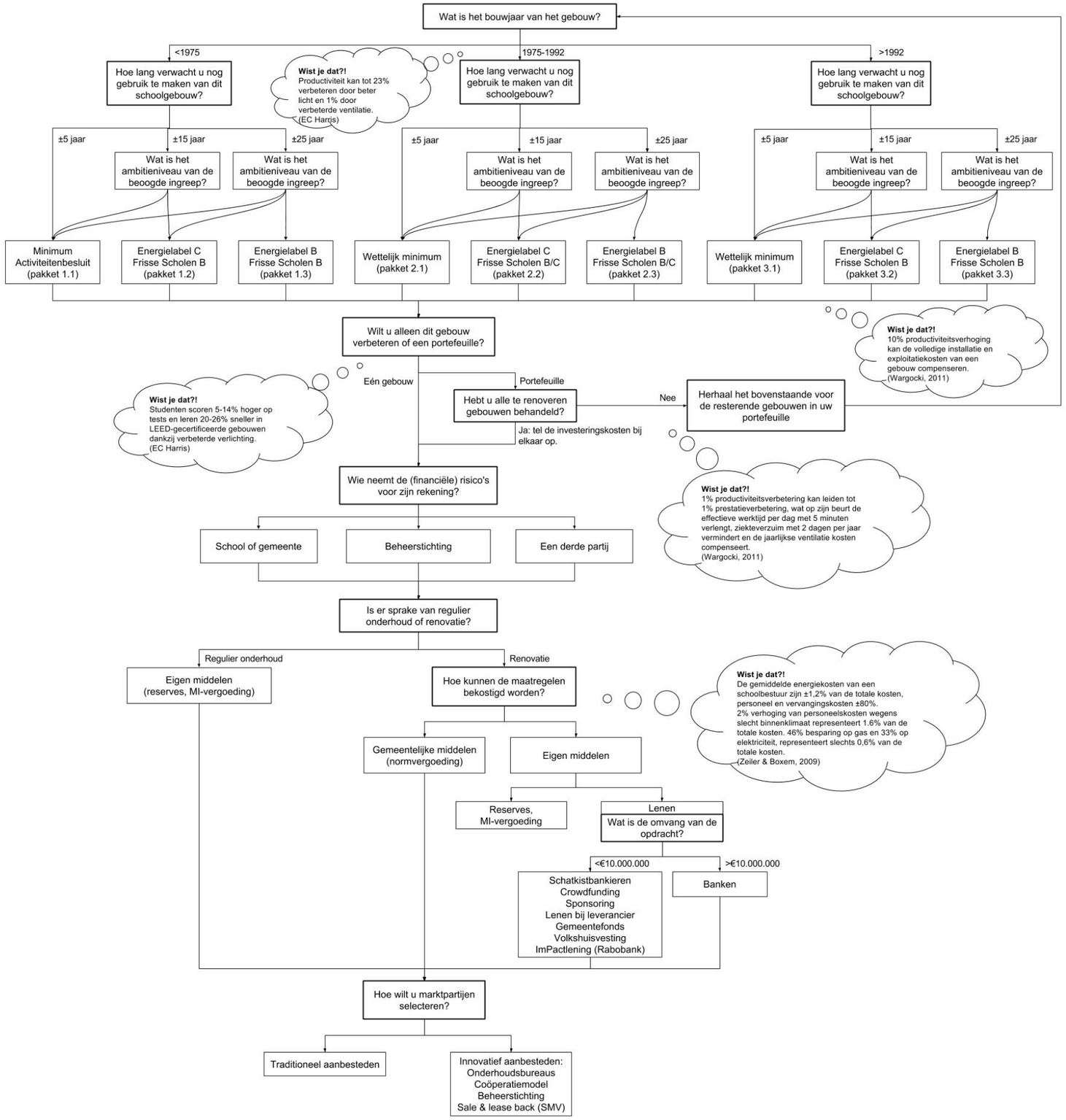

Figure 4 Decision flowchart design

Table 5 Sustainable measure packages

Maatregelpakketten PO											Effect maatregelen op:				
		<1975			1975--1992			>1992				Binnenmilieu			
		5 jaar	15 jaar	25 jaar	5 jaar	15 jaar	25 jaar	5 jaar	15 jaar	25 jaar					
Thema	Maatregelen	1.1 Minimum Activiteitenbesluit	1.2 Energielabel C Frisse Scholen B	1.3 Energielabel B Frisse Scholen B	2.1 Wettelijk minimum	2.2 Energielabel C Frisse Scholen B	2.3 Energielabel B Frisse Scholen B	3.1 Wettelijk minimum	3.2 Energielabel C Frisse Scholen B	3.3 Energielabel B Frisse Scholen B	Energie	Luchtkwaliteit	Temperatuur	Licht	Geluid
Isolatie	Spouwmuur* (Rc = 4,5)	1									+		+		+
	Buitengevel (Rc = 4,5)		1	1		1	1		1	1	+		+		+
	Dak (Rc = 6)			1			1			1	+		+		
	Vloer (Rc = 3,5)		1	1		1	1		1	1	+		+		
	Kierdichting		1	1		1	1		1	1	+		+		+
	HR++ beglazing (U-waarde = 1,2)		1	1		1	1		1	1	+				+
	Isolatie ventilatiekanalen		1	1		1	1		1	1	+				+
	Isolatie warmteleidingen*	1	1	1	1	1	1	1	1	1	+	+			
Ventilatie	Tijdschakeling ventilatie*	1	1	1	1	1	1	1	1	1	+	+			
	Cascaderegeling ventilatie*	1	1	1	1	1	1	1	1	1	+	+			
	(indien mech. toe-en afvoer) Warmteterugwinning ventilatie*							1	1	1	+	+	+		
	(+WTW) Mechanische toe- en afvoer (in aantal lokalen)		8	8		8	8					+			
Verwarming & Koeling	Weersafhankelijke regeling aanvoer verwarming*	1	1	1	1	1	1	1	1	1	+				
	Weersafhankelijke regeling opstarttijden verwarming*	1	1	1	1	1	1	1	1	1	+				
	HR107 ketel*	1			1						+	+	+		
	Buitenzonwering		1	1		1	1		1	1	+		+	+	
	Warmtepomp (inlc. Radiatoren op LTV)		1	1		1	1		1	1	+		+		
	WKO			1			1			1	+				
Verlichting	Veegpulsschakeling*	1	1		1	1					+				
	Aanwezigheids- + daglichtdetectie			1			1			1	+				
	LED verlichting*	1	1	1	1	1	1	1	1	1	+			+	
Opwekking	Zonnepanelen per m2			300			300			300	+				
Kosten	Investeringskosten per m^2 Bruto Vloeroppervlak (excl. BTW)	€ 97	€ 325	€ 483	€ 33	€ 325	€ 483	€ 43	€ 360	€ 519					
	Investeringskosten per m^2 Bruto Vloeroppervlak (incl. BTW)	€ 117	€ 393	€ 584	€ 40	€ 393	€ 584	€ 52	€ 436	€ 628					
	Aanvullende investeringskosten (excl. BTW)	€ 5.700	€ 105.700	€ 182.200	€ 5.700	€ 105.700	€ 182.200	€ 5.700	€ 5.700	€ 82.200					
	Aanvullende investeringskosten (incl. BTW)	€ 6.897	€ 127.897	€ 220.462	€ 6.897	€ 127.897	€ 220.462	€ 6.897	€ 6.897	€ 99.462					
	Terugverdienperiode in jaren	5	15	25	5	15	25	5	15	25					
Voorbeeld investeringskosten: PO school met opp. 1.300 m^2 BVO (8 lokalen)		€ 159.250	€ 639.105	€ 979.984	€ 59.278	€ 639.105	€ 979.984	€ 74.851	€ 573.318	€ 915.612					
Frisse Scholen thema	Energie	-	C	B	C	C	B	C	C	B					
	Lucht	-	B	B	C	C	C	C	B	B					
	Temperatuur	C	B	B	C	B	B	C	B	B					
	Geluid	C	B	B	B	B	B	B	B	B					
	Licht	B	B	B	B	B	B	B	B	B					

*Erkende maatregelen Activiteitenregeling milieubeheer