Sustainable cities and communities – Best practices for structuring a SDG model

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Abstract. The UN’s SDGs are powerful beacons to a better world yet some of their targets remain vague for the sake of special interest groups. They are sometimes synergetic and quite often ambivalent. On a concrete operative level it is therefore a challenge to plan for them fostering synergetic measures and minimizing trade-offs. Since many concrete projects that go for the SDGs are rather unique and need to consider many stakeholders, the systemic approach of a participatory explorative cause and effect modeling should be applied in order to tackle the underlying complexity of these projects. On the example of SDG 11 and with the use of the software iMODELER the approach is presented offering some best practice for structuring a SDG model, facilitating participatory stakeholder workshops, identifying levers for successful action, and establishing a culture of reflection. Although this approach has been applied successfully in Africa as well as in Germany it is also crucial to prevent typical hindrances. A kind of template for a model structure will be presented for both, a town in a developing country and a town in an industrialized country.

1. Sustainable cities and communities (SDG 11) – a complex challenge

Aiming for sustainable cities and communities should imply all three dimensions of sustainability – the social, the economic and the environmental. The United Nation’s 17 Sustainable Development Goals (SDG) and their 169 targets represent these three dimensions of sustainability and only looking at their interconnections [14] reveals that some of them in practice could be contradictory resulting in necessary trade-offs while others might be synergetic at least in the long run.

Any strategic planning for sustainable cities and communities in general and following the SDGs in particular thus needs to consider this interplay of economic, social and environmental aspects. However, the prevailing practice seems to be economic aspects first followed by either social or environmental ones when regions seek for investors who aim for short term return on investment which often contradicts the provision of living space for low income families as well as the investment into green technology, better insulation, and the use of more expensive renewable materials. Environmental criteria could be set by regulation or demand. Social criteria are set only by regulation, or the lack of demand for the same space from higher income target groups that allow for higher margins for those who sell or lend space as well as for a higher tax income for the local government and higher revenues for local businesses.

All too often, thus, new buildings serve some short-term demand often in so-called pork cycles when many projects try to serve the same target group resulting in a delayed oversupply. Neither demographic change of more, less, or aging people, nor variations from demand driven prices and their long-term financing are considered. Also, if each plot seeks to maximize the utilized area and go for individual designs the region will lack green spaces and an attractive look from a common design denominator. So each region seeks to attract businesses and residents in order to provide jobs and tax income and its seems odd to argue for less short term economic gains for a greater benefit of society and long term economic opportunities as well.
The strategic planning becomes even more complex if we consider social aspects like the integration of different social milieus living in the same area (SDG target 11.A), visiting the same schools, and sharing leisure activities in order to increase variety for the greater benefit of society [9]. Adding to that a planning for intelligent mobility, public transportation, short distances, infrastructure for decentralized energy supply and optimized waste management for the long run becomes even more of a challenge since many planners are used to basing their assumptions on rather linear thinking and some sort of sovereignty of interpretation qua position.

This paper provides a tool - not a case study - to overcome this linear thinking and develop strategies that best fit the many SDG targets by revealing trade-offs and synergies. Therefore the aspects or examples mentioned are rather general, often trivial.

2. Reflecting on projects through explorative qualitative stakeholder modeling

Complex challenges in general are characterized by a large number of factors that need to be considered, by a large number of interconnections that form dynamics from so called feedback loops [18], [19], or by unpredictable behavior from elements in a system [7], [2], e.g. humans or the environment.

That means that unlike complicated challenges complex ones can never be fully predicted, yet there are tools for modeling that help us to overcome the limitations of our mind [6] to grasp the range of possible consequences from our decisions.

Modeling in general [19] means that we consider our challenge being a system that is defined by the interplay of its elements and that we need to define so-called system boundaries (time, space, detail), find a way to consider the crucial elements, and describe their interplay either qualitatively [12], [17] or quantitatively (through either System Dynamics, Agent Based Modeling or Neural Networks).

The next paragraphs will show a powerful way of qualitative modeling of a strategic plan to achieve the SDGs.

2.1. General approaches on modeling the SDGs

The number of approaches [1] to model the interplay of the SDGs is constantly rising. There are for example applications [8] of the iSDG by the Millennium Institute (www.millennium-institute.org) or the qualitative approach by the Stockholm Environment Institute [15]. And there is even an approach deriving causation from correlation of data from the target’s indicators [16]. These approaches are obviously quite sophisticated and not easily applicable for concrete regions since only more or less predefined but no individual, potentially crucial aspects are included, and since the math and the use of the tools are typically expert’s but not stakeholder’s work.

2.2. Explorative modeling

As mentioned before it is crucial to consider the decisive elements – also called factors - of a system in order to grasp the underlying complexity. One way, of course, would be to already know what they are. In that case a model of their interplay would be descriptive. However, that seems very unlikely and therefore these kinds of challenges require what can be called explorative modeling.

Though there will never be a guarantee to have included the decisive factors there are ways to increase the likelihood of it. One way is to ask the stakeholders as described in the next sub-chapter. Another is to systematically ask the right questions for each factor within the model until the concrete measures and their dependencies are found. Established are the so-called four know-why questions from the know-why method [13].

They simply ask:

- What leads directly to more of a factor?
- What leads directly to less of a factor?
- What might lead directly to more in the future?
- What might lead directly to less in the future?

A facilitator of a workshop for example should then vary these questions and ask for organizational, financial, psychological, legal, etc. factors. The result is the visualization of arguments through factors that are connected with arrows either labeled with a “+” or a “-” meaning that more of one factor leads directly to more/less of the other factor. This way of presenting arguments can be seen as a kind of lingua franca that works in interdisciplinary professional settings as well as with kids in
elementary school. Any project, strategy, paper, newspaper article or discussion can be visualized in this way [12].

2.3. Stakeholder modeling
There are two reasons for so called stakeholder modeling and some requirements to get it working. First, as already mentioned, we need to include the decisive factors and often there is information that isn’t known to the decision makers or it gets underestimated in its potential consequences since it is not properly put into perspective.

The other reason is when you present your model containing hundreds of factors and the conclusion you draw from its analysis many people will reject what they don’t take the time for to look into the details and of which they were no part of.

The requirements to get it working next to the ease of a lingua franca as described in the subchapter before are rather technical. The tool iMODELER (available as freeware, www.imodeler.info) that was applied for this paper is constantly being improved for this kind of modeling, offering:

• a change of perspective from which one is looking at the model so that different groups can work on selected factors without getting overwhelmed by the spaghetti look of hundreds of other factors and connections.

• a collaborative modeling feature so that not just the facilitator is typing input but anyone from a group that brings a computer or smartphone. That way they grow ownership and navigate through the model by themselves looking for further crucial arguments.

• a repository of existing models to get proposals for further relevant factors from other cases, as given with www.know-why.net and the possibility to intelligently search all its factors right from a factor of one's own model. Stakeholder can then easily evaluate the need to include these proposals.

• a link directly to the model so it can be read and discussed beyond a stakeholder workshop.

The iMODELER has been applied for stakeholder - also called 'participatory' - modeling in various projects on SDGs [14] and regional development [10].

2.4. Qualitative modeling
The major reason to apply so called qualitative modeling probably lies in the effort it takes to build quantitative models and use data and formulas. Another often-named [11] reason for its use is its potential to translate fuzzy and qualitative arguments directly into a model, which is particularly important for participatory stakeholder modeling.

‘Qualitative’ means that an interconnection is defined simply by the already described arrows in iMODELER, and the modelers then later, once all influencing factors are connected, are able to decide whether this influence is weak, medium, or strong compared to other influences on the same factor. Also to be decided is whether these influences change from short- to medium- to long-term (figure 1).

From this rough, fuzzy differentiations as shown with the next subchapter some powerful conclusions can be drawn. It is important to note that stakeholders can easily agree on these rough weightings.
2.5. Qualitative analysis featuring the Insight Matrix

Simulations of quantitative models show how, and with what likelihood something develops over time. A qualitative model can only compare impacts of factors within a system of interconnections, e.g. showing the potentially biggest risks or most promising action short-term, medium-term, and long-term with regard to a target factor of a model. Since these impacts stem from potentially various impact chains and interfering feedback loops that can be reinforcing or balancing it takes a computer to process the resulting effects [6]. The iMODELER offers an Insight Matrix [12] to compare the influences (horizontal x-axis) of factors and their change of impact over time (vertical y-axis) as shown in figure 2.

Reinforcing feedback loops could be both, virtuous or vicious cycles. For example more tax income from businesses could allow for more investments into public spaces that attract better-educated residents, thereby attracting more businesses. This dynamic can lead to both, an increasingly better region or an increasingly less attractive region.

An example of a balancing feedback loop could be that a dire situation causes pressure for political action and, once that action is taken and takes effect, leads to less pressure.

Modeling the SDG 11, Sustainable Cities and Communities, for a concrete region means that at least one factor is representing this goal. From its Insight Matrix the most important risks or hindrances as well as concrete actions should be derived. If one then continues to look at the Insight Matrices of these hindrances and actions, synergies and ambivalences or trade-offs can be identified that reveal crucial otherwise hidden aspects for successful strategies and projects [20].
3. Templates to reflect on the creation of sustainable cities and communities

In principal one can start a model on the development of sustainable cities and communities from scratch by starting with that as a target factor and asking the aforementioned four know-why questions to explore the possible action and hindrances and their dynamics. But since the SDGs already feature sub targets for each goal and since they are meant to not been followed as isolated targets but rather synergetic it makes perfect sense to look at templates that have already connected the cause and effect relations between the targets and hence the goals.

One example that is publicly available and already featured in a published paper is the SDG model on know-why.net (https://www.know-why.net/model/CaLIsTKbVf7Yg5bm8yRXGyg) here shown with figure 3. It has more than 200 factors, more than 450 connections, and more than 13 million feedback loops.

**Figure 2.** Insight Matrix to compare the influence of factors over time.
Figure 3. Screenshot of the general SDG cause and effect model from know-why.net.

Though it is a rather general model not focusing on a concrete region, it should be helpful to look for potential connections of each target with other targets. The model does not just connect the targets of the SDGs, it uses additional factors in order to explore and explain their interconnections.

Right at the beginning of the model an overall target called “well being in the world” was inserted and only 7 of the 17 SDGs directly influence this overall target while the rest are supporting these factors in some way.

Also between some of the targets the model features additional factors to show the interconnections. For example between SDG 8, Decent Work and Economic Growth, and many targets of SDG 17 on financing there are two factors, the “national budget in richer countries” and “richer countries’ willingness for financial help”, both influenced by further factors. This adds the possibility to explore the levers and hindrances for making a change actually happen.

It is crucial not to directly connect factors, for example each of the 169 targets with the overall target of well being in the world, if they are actually to be connected indirectly via other factors. The differentiated look at indirect connections, the so called cause chains and the feedback loops, is the added value of modeling. Drawing redundant direct connections [17] would make it impossible to draw conclusions from the model and its analysis.

Figure 4 shows the general model from the perspective of SDG 11:
Figure 4. Screenshot from the general SDG model from the perspective of SDG 11.

Figure 5 shows the model from the perspective of SDG 7 and how this is connected to other sub targets and SDG 11 itself:

Figure 5. The general SDG model from the perspective of a sub target

Already the general model on SDGs reveals with its Insight Matrix of SDG 11 (figure 2) which targets from other SDGs are synergetic and which ones have the potential to be ambivalent. However, for a concrete region a facilitator can prepare a more concrete template.
3.1. Application for the "industrialized world"
The so-called industrialized world’s population is not growing as fast as it is aging. Therefore younger people do not inherit property from their elders and need their own place to live in, which is why despite sometimes even shrinking populations there is a need for more housing. However, this implies a foreseeable decrease of need in the long run unless migration compensates for the low birth rates in those countries. A logical consequence is also the growing need for smaller and disabled friendly units. Some regions still face a rural exodus though this might change with growing numbers of home office workers and decentralized businesses [3].

Its infrastructure (e.g. SDG targets 9.1 and 11.2) features public transportation though road traffic from private cars dominates the need for space for roads and parking areas. Only recently some cities seek to provide more space for bicycle traffic. The trend to use cars to drive to outlet centers and to go for online shopping causes cities to lose businesses. The cities and their quarters thus need to plan for attractive, decentralized services that are accessible via public transportation.

Green spaces (SDG target 11.7), however, become rare since there is still a need for more housing coupled with an increase of real estate prices that could be derived from the low interest rates in the wake of the last financial crisis. And since the interest rates are low and prices are high there are widespread investment booms into new housing anywhere resulting in the pork cycle that was mentioned in the introduction. One challenge here is that today’s standard will define the anthropogenic stock of resources (SDG target 8.4) and the need for energy (SDG target 7.3) for many decades to come.

Waste-water management (SDG 11.6), power supply (SDG 7), even communication cables are mostly established, yet infrastructure for the rise of e-mobility requires additional power lines and charging stations. As areas for photovoltaic panels rooftops and walls as well as pathways could be used. Rooftops also may serve as areas for urban gardening.

Active housing, that which supplies more power than it consumes, intergenerational living, short distances, access to public transportation and a lot more necessary for becoming more sustainable remains quite a challenge that requires reflection of its cause and impact relations. A model should always start defining the questions that it should help to answer! If it is the question “How to plan for a sustainable city and community?” the existing SDG model could be used as a starting point. Some targets, like ‘11.1 access to adequate housing and basic services’, need to be either marginalized with a low weighing of their impact for a rich industrialized country, or they need to be differently interpreted e.g. as housing for all ages and income classes. Otherwise, they need to be referred to a partner city in a less developed country.

A factor like target ‘7.3 double energy efficiency world wide’ is also interesting in its interpretation whether it means that the already high standards in industrialized countries should be increased or that they are allowed to point at higher possible margins of improvement in other areas of the world.

Starting from the given factors in the template one should continue with the four know-why questions until finally coming up with some concrete action and its required reflection. So, if for example, ’street lamps serving as charging station for e-cars’ is the concrete action, one should ask how to finance it, what might cause problems, what might be a legal aspect, what is technically necessary, what might be the technology of the future, and so forth.

If it is a more detailed question that the model should answer, the model could start from scratch and use the SDG template only as a reference for inspiration. The four know-why questions should help develop a powerful explorative cause and effect model. In the context of buildings and infrastructure the questions should be varied and ask for financial, legal, organizational, social/cultural and technical levers and hindrances.

3.2. Application for the "developing world"
The so-called developing world has many more dynamics to consider when planning for its sustainable cities and communities. The worst way to develop would be the uncontrolled urbanization with all its problems of water supply, wastewater management, air pollution from road traffic, lack of standards to mitigate the effects from potential disasters (SDG target 11.4), and so forth. The second best way would be to copy the development of the industrialized world with its dominance of road traffic and the separation (neglecting SDG target 11. A) of privileged living areas from housing blocks or even slums for socially disadvantaged people. The best way would be to consider some leapfrogging to plan for cities that are more modern and sustainable than that of the industrialized world since many parts of them can almost be built from scratch.

In any case the developing parts of the world need investments. They could come from SDG target ‘11.C financial support to least developed countries for sustainable buildings’, from investors that seek
to profit from the domestic economy, from investors that seek to support the location of their business, or from investors that want to attract tourism. And, of course, there is still the possibility that a region does not strive for the typical western lifestyle with cars, petrochemical products and loads of luxury goods but instead embraces a more resilient, community centered way of living that could be based on a local bio-economy or sustainable tourism.

As for the template for a model for the industrialized world the questions that the model should answer are crucial. For rather general strategies and projects one could use the existing general SDG model. For more specific questions one might develop a completely new model using the explorative know-why questions again. One difference might be an increased emphasis on the questions what might lead to more or less in the future. For example, arguing for wider and more streets because of the increase of traffic jams that are bad for local business and investments, knowing that the future is emission free public transportation and even that of electric commercial vehicles, would be a typical shifting the burden archetype [18].

4. Beyond the tool – a culture of reflection

This paper shows no concrete application with conclusions from a model’s analyses nor a step-by-step guidance. Rather it recommends, together with the provision of some tips and tricks from other projects, to use participatory explorative cause and effect modeling to reflect on concrete challenges in order to make progress achieving SDG 11. The fact that a concrete example would not imply a best practice for elsewhere is the very reason one should refer to this methodology: the challenges this world faces need individual solutions that consider the unique circumstances of every region.

Yet, trying to apply this approach quite often faces typical resistance. People doubt the benefits from these models since they consider them to be based just on assumptions. Well, that is correct. But any other approach, even that of a mere copying of ‘fact based’ best practice from elsewhere, would be based on assumptions as well, with the only difference that a model visualizes these assumptions, allows for their discussion, fosters creativity, and reveals logical conclusions from abductive logic [4].

Best practices are helpful but for a better future we need to add well-reflected ideas. The following photos (figure 7) show two paintings from unknown artists from an international Degrowth conference 2014 in Leipzig, Germany. One depicts for a better future a good life for all “Gutes Leben für alle” next to best practice solutions a group of people standing around a cause and effect model developing a shared idea. The other picture shows the unhealthy automatisms of more growth “Mehr Wachstum” by mere copying of lifestyles.

![Figure 6. Drawings comparing the current and alternative paths for society.](image)

This kind of collaborative problem solving (CPS) is subject to a psychological science [5]. It is considered a crucial skill for the future that can be trained and measured. Politicians, consultants, actors for media and other organizations, and indeed all of us need to learn to ask for the interplay of many factors and discuss this with others instead of restraining ourselves to best practice or gut feeling just because knowing feels better than taking the effort of exploration.
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