

Instructions to Draw the SusAD

The Sustainability Analysis Diagram (SusAD) is a visualization tool for capturing potential effects of systems. It is not an end in itself, rather its objective is to support discussion among stakeholders.

The SusAD is composed of **five dimensions** and **three order of effects**, describe as follows:

Definition of dimensions [Becker et al. 2016]:

Individual dimension: covers individual freedom and agency (the ability to act in an environment), human dignity, and fulfillment. It includes individuals' ability to thrive, exercise their rights, and develop freely.

Social dimension: covers relationships between individuals and groups. For example, it covers the structures of mutual trust and communication in a social system and the balance between conflicting interests.

Economic dimension: covers financial aspects and business value. It includes capital growth and liquidity, investment questions, and financial operations.

Technical dimension: covers the ability to maintain and evolve artificial systems (such as software) over time. It refers to maintenance and evolution, resilience, and the ease of system transitions.

Environmental dimension: covers the use and stewardship of natural resources. It includes questions ranging from immediate waste production and energy consumption to the balance of local ecosystems and climate change concerns.

Orders of Effects [Becker et al. 2016, adapted from Hilty & Aebischer 2015]:

Immediate effects: are direct effects of the production, use and disposal of software systems. This includes the immediate benefit of system features and the full lifecycle impacts, as would be included in a Life-Cycle Assessment (LCA) approach, which evaluates the environmental impact of a product's life from the extraction of raw materials to its disposal or recycling.

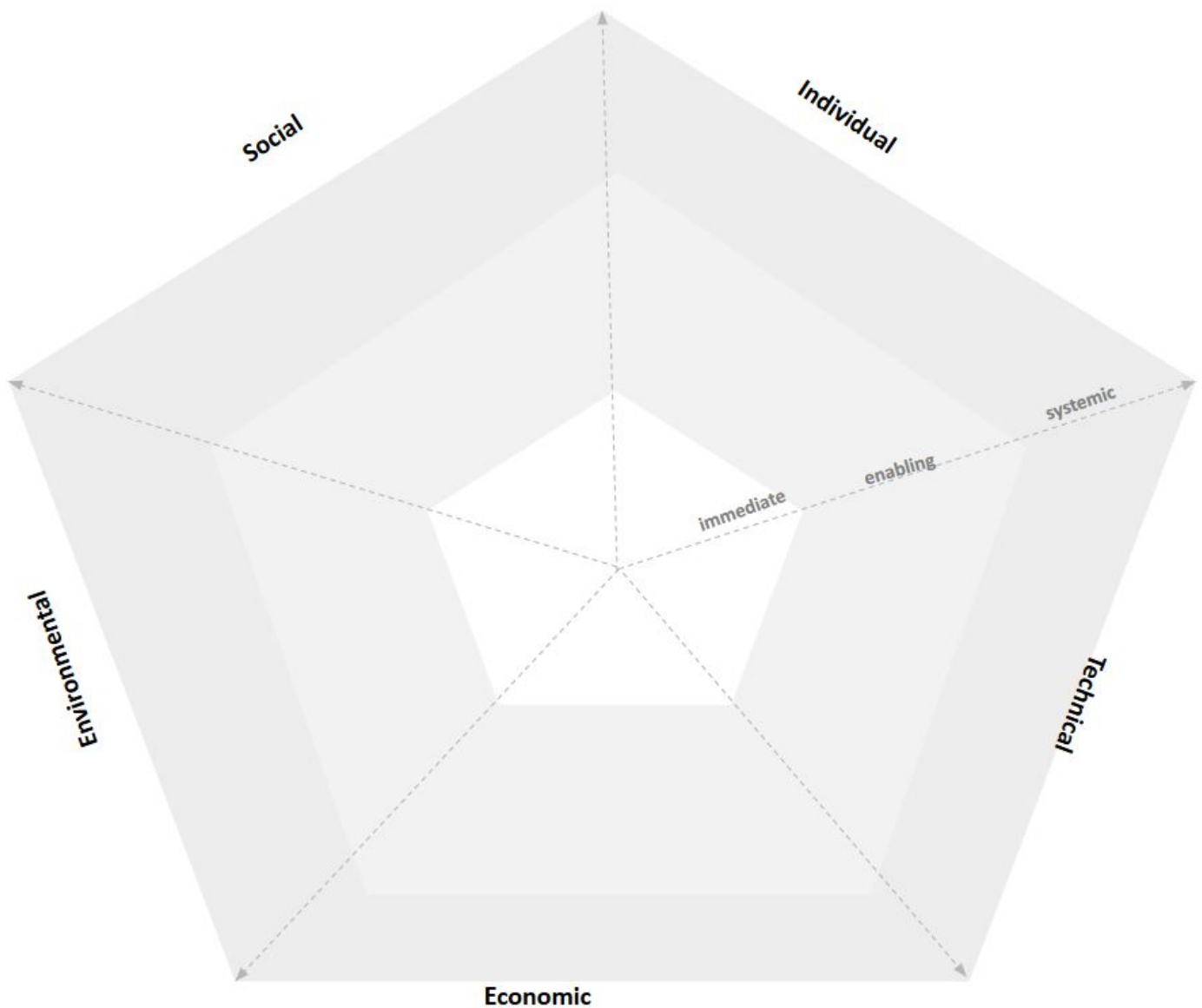
Enabling effects: arise from the application of a system over time. This includes opportunities to consume more (or less) resources, but also other changes induced by the usage of a system.

Structural effects: represent "persistent changes observable at the macro level. Structures emerge from the entirety of actions at the micro level and, in turn, influence these actions" [8]. Ongoing use of a new software system can lead to shifts in accumulation of capital, drive changes in social norms, policies and laws, and alter our relationship with the natural world.

Example [Becker et al. 2016] :

Consider the **airbnb.com** service. Its **immediate effects** include resources consumed and jobs created during its development, energy consumed during its deployment, and the room renting and booking services it offers. Its enabling effects include changes in how its users make travel arrangements as alternatives to hotel bookings, and how property owners rent out space. These **enabling effects** (the so-called "sharing economy") have been alternatively praised and criticized for their far-reaching **structural impacts**: for example, airbnb represents a substantial share of the buy-to-let market in major cities, and the continuing price surges in the hot-spots of these cities have been linked to the density of buy-to-let properties. Many of these exist only because of the arbitrage provided by services such as airbnb: The system enables transactions that provide higher return on investment than long-term rentals. This has caused major concerns in several large cities.

The SusAD can be drawn **as variations** of the diagram below. Each dimension is divided in three order of effects, being the immediate in the center , the enabling in the middle and the systemic in the most external layer of the diagram.



In order to fill out the SusAD, one normally start by answering a [set of questions](#) and trying to explore the mid and long-term effects associated with these questions. Ideally, questions would be answered by domain experts and/or experts in the above dimensions. Normally this exercise uncovers a large number of potential impacts, one that lead to another along dimensions and order effects.

Trying to capture all the impacts in a single diagram **would make it unreadable and of limited use**. Therefore the SusAD normally captures portions of the potential effects that one wants to discuss with the stakeholders.

We will next describe alternative ways to draw the diagram, for that we will use the example of a procurement system.

Sustainable Procurement System, adapted from [C. Bomfim 2014]:

The **sustainable procurement system** supports a company in the process of **purchasing goods** and to **contracting services**. It aims to **reduce costs**, to **ease the process** of purchasing and contracting, and to **ensure compliance** rules.

The system **adapts the ICLEI Procura+ methodology** (a guideline for sustainable procurement) . For such, the systems evaluates the products, services and suppliers with respect to social, economic and environmental issues and calculates “**sustainability levels**” for products.

A tool will be developed for supporting the drawing of the SusAD. In the meanwhile, it should be **drawn manually**.

Steps to draw the SuSAD:

1. Choose which issues to represent (e.g. Social/sense of community/equality):

<ul style="list-style-type: none"> <input type="checkbox"/> Social <ul style="list-style-type: none"> Sense of Community <ul style="list-style-type: none"> <input type="checkbox"/> Trust <input type="checkbox"/> Inclusiveness & Diversity <input type="checkbox"/> Equality <input type="checkbox"/> Participation and Communication <input type="checkbox"/> Individual <ul style="list-style-type: none"> <input type="checkbox"/> Health <input type="checkbox"/> Lifelong learning <input type="checkbox"/> Privacy <input type="checkbox"/> Safety <input type="checkbox"/> Agency <input type="checkbox"/> Environmental <ul style="list-style-type: none"> <input type="checkbox"/> Material and Resources <input type="checkbox"/> Soil, Atmospheric and Water Pollution <input type="checkbox"/> Energy <input type="checkbox"/> Biodiversity and Land Use <input type="checkbox"/> Logistics and Transportation 	<ul style="list-style-type: none"> <input type="checkbox"/> Economic <ul style="list-style-type: none"> <input type="checkbox"/> Value <input type="checkbox"/> Customer Relationship Management (CRM) <input type="checkbox"/> Supply chain <input type="checkbox"/> Governance & Processes <input type="checkbox"/> Innovation and R&D <input type="checkbox"/> Technical <ul style="list-style-type: none"> <input type="checkbox"/> Maintainability <input type="checkbox"/> Usability <input type="checkbox"/> Extensibility & Adaptability <input type="checkbox"/> Security <input type="checkbox"/> Scalability
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2) Summarize the main impacts of the technology in a text format for the issues of interest. Identify whether they are immediate, enabling or systemic and which dimensions they affect. Highlight keywords and orders of effects:

1.4 Equality

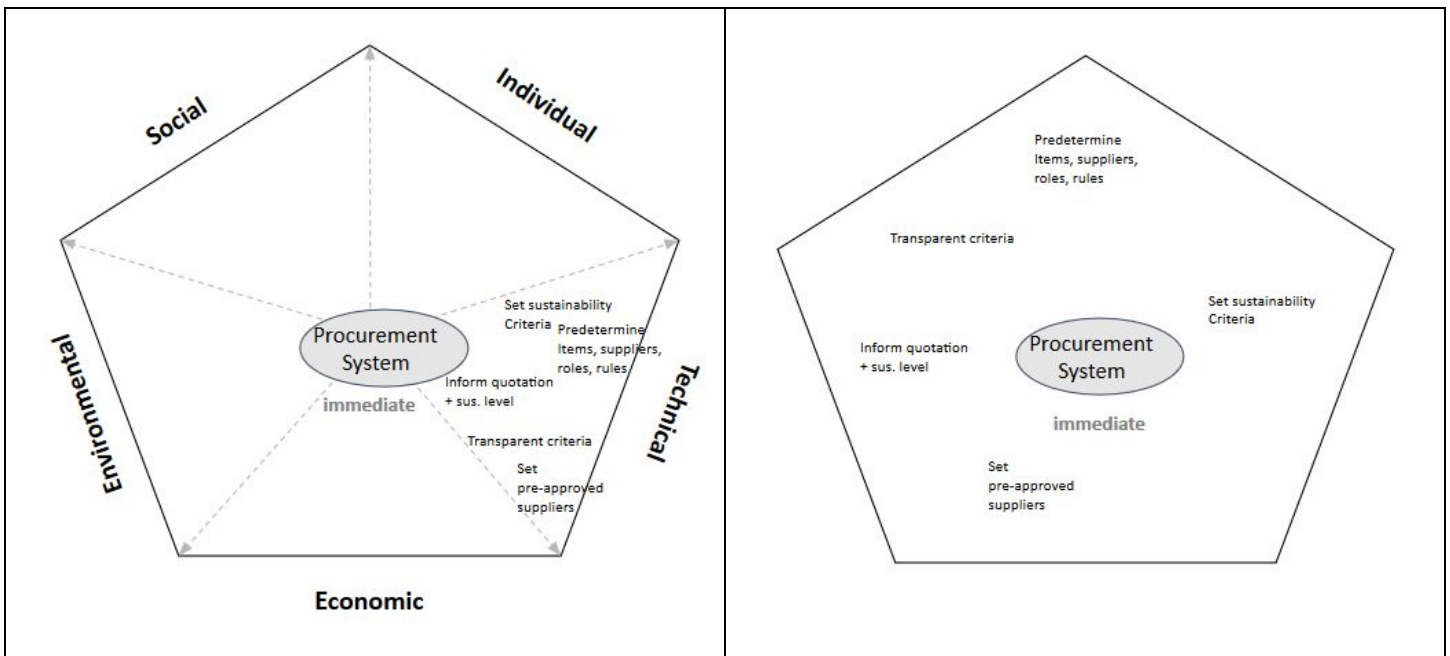
- 1.4.1. The system does not make automatic decisions. It only **informs the quotation from suppliers and the sustainability levels** of products, services and providers (**immediate effect**). As long as the **criteria is transparent**, including who is allowed to request what (**immediate effect**), the system does **treat people's requests equally**.
- 1.4.2. The system **predetermines the products, services, suppliers, requesters and approvers** (**immediate effect**). The type of products and services that one can request/approve depends on the person's department and role. Some **staff may resent other roles and/or departments** for being allowed to request certain items or for being able to issue urgent requests (**enabling effect, equality, social**). These staff members may **feel they are not being fairly treated**, since their **unmet needs** (**enabling effect, equality, social**) are also legitimate but may not be predicted in the rules of the system.
- 1.4.3. If some staff members resent others for having "privileges" in the procurement process, there may be **more conflicts** within the company (**enabling effects, social**) or some may feel **less devoted to the company** (**enabling effects, economic**), eventually leading to **lower productivity** (**enabling effects, economic**) and **lower profits** (**enabling effects, economic**)
- 1.4.4. The system only allows purchases from **suppliers who have passed Oil.Br's approval process**, which may lead to **Oil.Br always buying from the same providers**. If a large amount of companies did the same, it could be more **difficult for new businesses** to enter the market. (**systemic effect, economic**)
- 1.4.5. If it is more difficult for suppliers to enter the market, there could be **more concentration of wealth** (**systemic effect, economic**) and **less equality in the society** (**systemic effect, social**). If **local and small businesses are favored** (**enabling effect, economic**) in the **calculation of sustainability levels** (**immediate effect**), there could be **less monopoly by big businesses**, a better **distribution of wealth** (**systemic effect, economic**), and **greater equality** (**systemic effect, social**)

Note about immediate effects:

In software systems, it is common that immediate effects can be related to dimensions as follows:

Effect	Dimension
Software functionality/characteristics	Technical
Raw materials use	Environmental
Energy use	Environmental
Development process	Social / Individual
Development costs	Economic

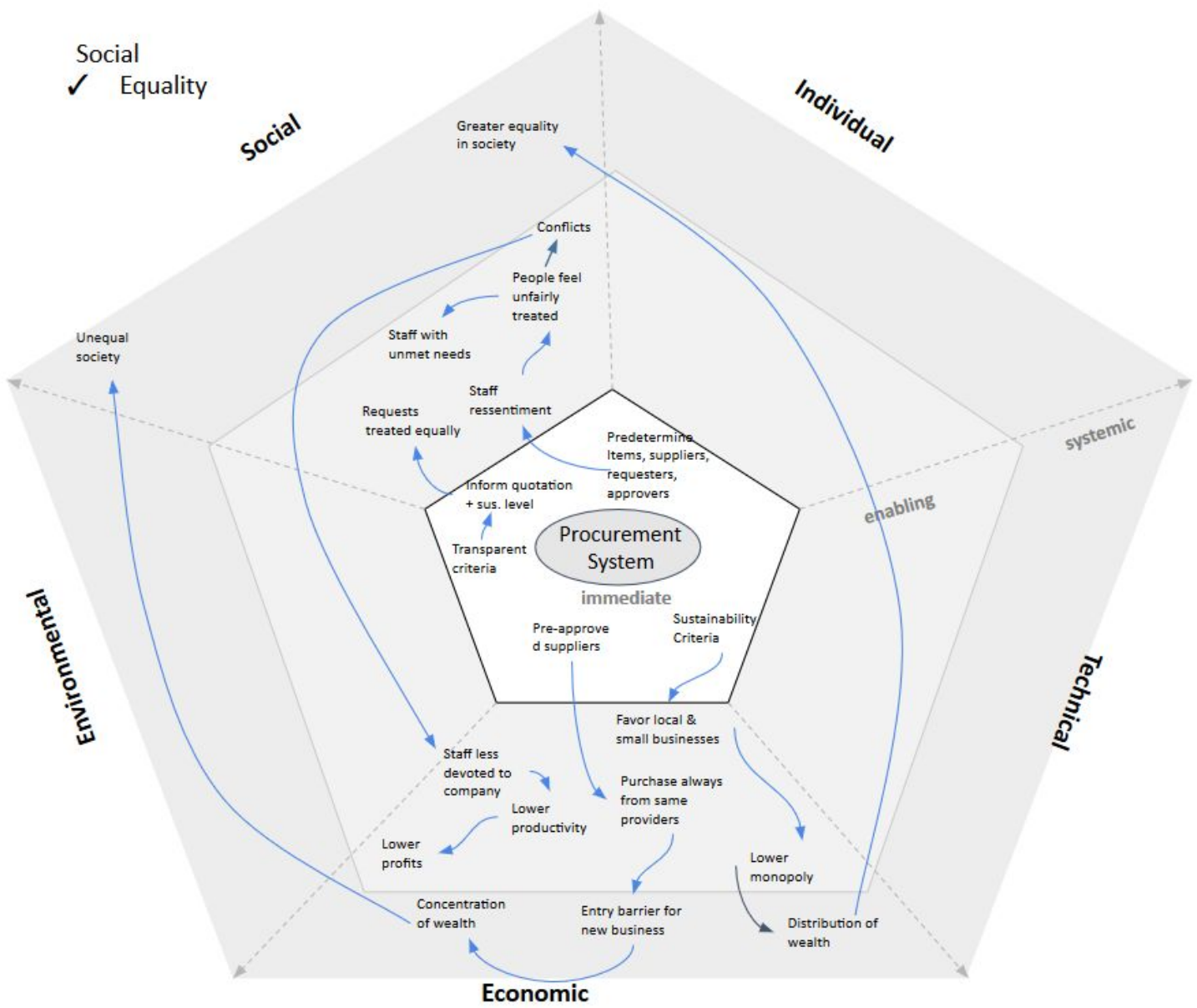
However, the number of software functionalities/characteristics are greater and drawing immediate effects within dimensions may not bring much benefit to the discussions. So, an alternative is not to distinguish dimensions for immediate effects. Both are valid and shown below:



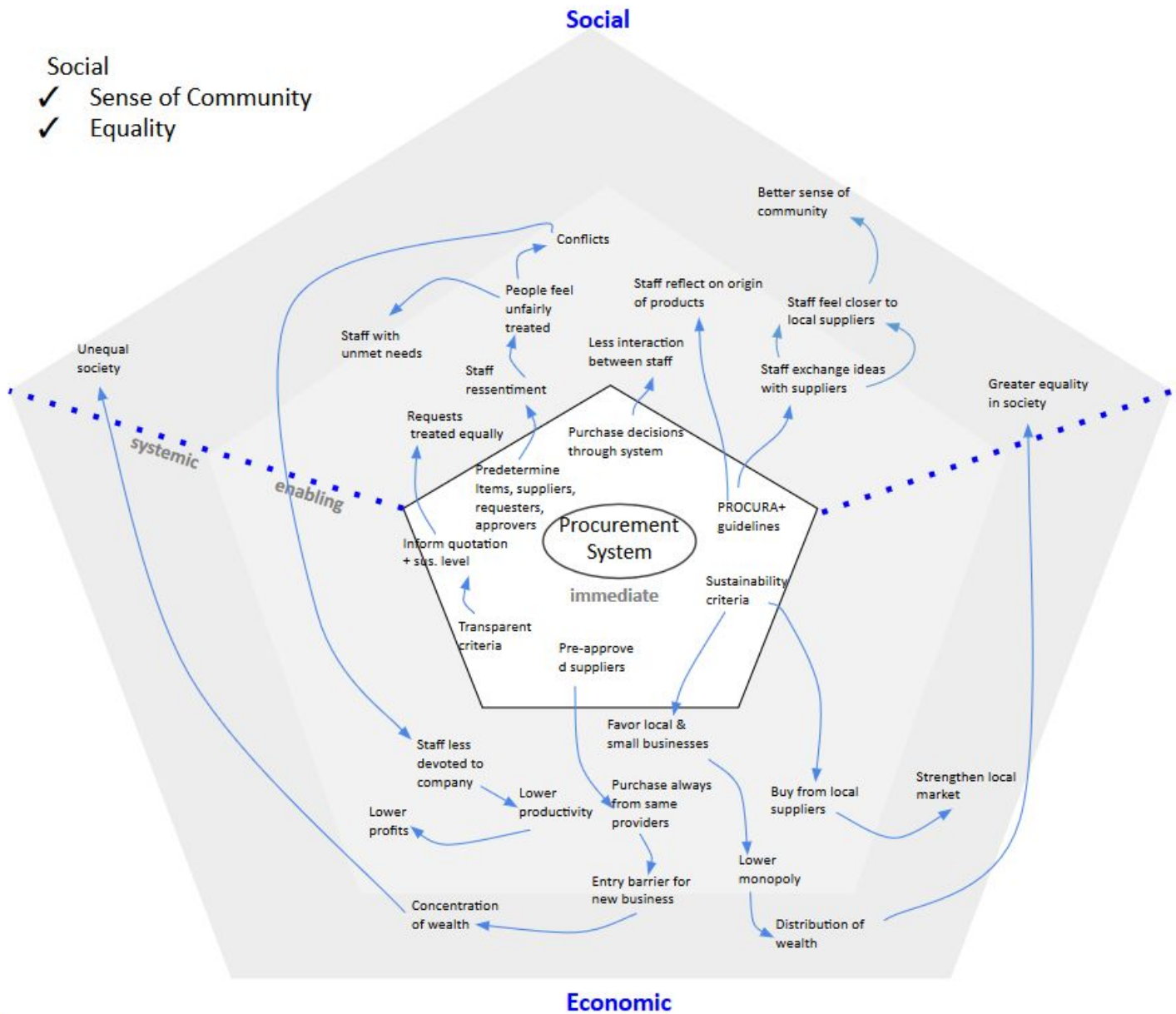
Distinguishing dimensions in immediate effects

Not distinguishing dimensions in immediate effects

3) Draw the SusAD using keywords and placing them in their respective order of effects:



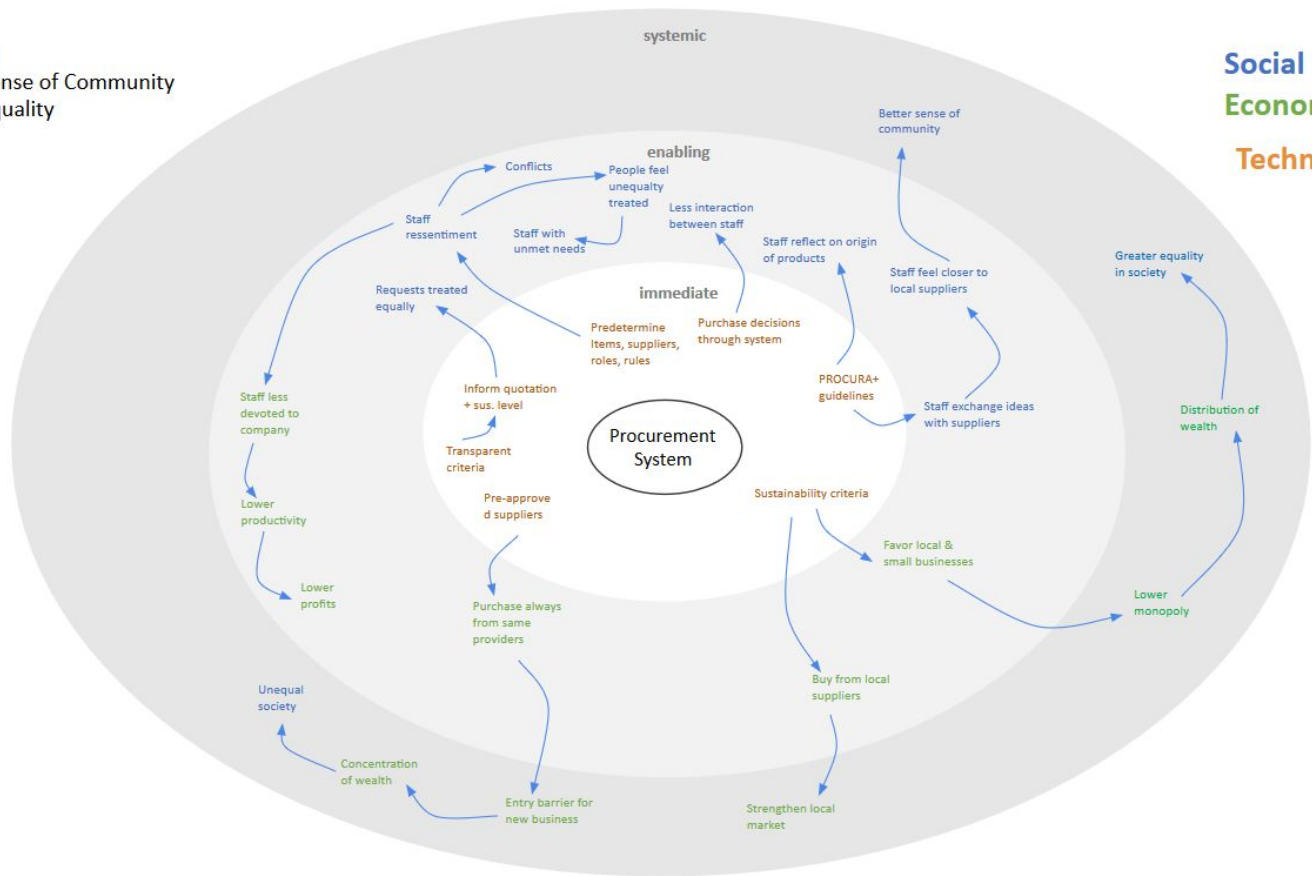
4) In order to ease the visualization, one can also represent on the diagram, only the dimensions of interest (e.g. social and economic). This also helps to display more than multiples issues in the SusAD (e.g. Sense of community and equality).



5) Alternatively, one can also differentiate the dimensions of the SusAD through graphic characteristics (e.g. colours):

- Social
- ✓ Sense of Community
- ✓ Equality

Social
Economic
Technical



References:

C. Becker *et al.*, "Requirements: The Key to Sustainability," in *IEEE Software*, vol. 33, no. 1, pp. 56-65, Jan.-Feb. 2016.

doi: 10.1109/MS.2015.158

C. Bomfim, W. Nunes, L. Duboc and M. Schots, "Modelling sustainability in a procurement system: An experience report," 2014 IEEE 22nd International Requirements Engineering Conference (RE), Karlskrona, 2014, pp. 402-411. doi: 10.1109/RE.2014.6912291

L. M. Hilty and B. Aebischer, "ICT for sustainability: An emerging research field," in *ICT Innovations for Sustainability*. Springer, 2015, pp. 3–36.