## Deliverable Report

### KAVA

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<thead>
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<th>KAVA Name</th>
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<td>KAVA Reference</td>
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### Deliverable

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DEL04 (Part 1): Comparative study on citizen engagement with vertical farming between Munich and London

EIT Food

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Disclaimer:
This report reflects the view of the author(s) of this report but it does not necessarily reflect the view of other partners involved in the project nor those of EIT Food.
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Executive Summary

The Technical University Munich used the Social Media Survey (SMS) tool in Munich and London. The degree of engagement was 111 participants in Munich within 3 days and 115 participants in London within 1.5 days. There were several differences concerning the overall setting of both events that limited the immediate comparability of the events in terms of audiences and setups. Keeping this limitation in mind, the following is a summary of the comparison between events.

There was a higher reported familiarity with VF in Munich compared to London (79% vs. 51%). Similarities in selected images (as visualized associations with VF) in Munich and London were the same high frequency of stacked, edible plants, pink light, people, technology, gardening, and buildings. Differences in selected images were: more associations with food in Munich, and more associations with white light and greenhouses in London. When describing their images, participants in Munich and London both frequently mentioned verticality, technology, future, and efficiency. A difference was that in Munich, the themes green colour and food were mentioned much more often than in London. In London, light (artificial light, lack of sunlight) was a much more popular topic than in Munich. Large-scale food production and aesthetic appeal were also more frequently mentioned in London compared to Munich. When describing the meaning of VF, similarities in Munich and London were the same high frequency of the themes verticality, efficiency and sustainability. Differences were firstly, the higher popularity of future, appeal of novelty, urbanism and food in Munich compared to London. In London, there was more focus on indoor cultivation, artificialness / unnaturalness and lighting. Technological innovation was popular with participants in Munich and London. In both locations, most participants reported that technological innovation was important or very important (83% in Munich and 90% in London).

Concerning influences on food decisions, ethical reasons and outdoor cultivation were similarly least important in Munich and London. Locality and organic labelling were more important in Munich than in London, whereas nutrition was more important in London than in Munich. Both in Munich and London, most participants did not want to disclose their age. Of the respondents that did indicate age, the average age was 35 in Munich and 37 in London. Both in Munich and London, many participants did not indicate residence. Amongst the respondents that did indicate residence, the most frequent answer in Munich was Germany (42%), and in London it was Great Britain (41%).

In conversations with event staff, participants in Munich reacted slightly more favourably towards VF than in London. Visitors in Munich and London both praised the potential to reduce pesticide use and increase food security. Visitors in both locations criticized high-energy use, perceived associations with GMO, exaggerated importance of technology, and unnaturalness (in Munich lamented as lack of soil, in London lamented as lack of sunlight). How humans live or should live together, in terms of ideas of urbanism and future, was a more popular focus in Munich than in London. Overall, comments about the meaning of VF were more positive and even idealistic in Munich compared to London. A particularly significant difference was higher scepticism towards unnaturalness or artificialness in London compared to Munich. Overall, citizens were curious about VF in London and Munich and in both locations praised efficiency in terms of space and resources, hopes for food security, a positive attitude towards the use of technology, and optimism for the future.
1. Introduction

The Cultivating Engagement Citizen Participation Forum consisted of two 3-day, walk-in events each in a science and technology museum in Germany and the United Kingdom, that is, the Deutsches Museum in Munich and the Science Museum in London. The project partners at TUM deemed these two museums suitable, for it provided similar settings in two countries that also corresponded with the comparative consumer research study between Germany and the UK (see DEL06). Here, citizens were invited to engage with vertical farming and discuss the technology’s societal and scientific implications. These walk-in events were aimed at exploring the social, economic and ethical aspects of this novel technology and products, and how these relate to food as a form of cultural identity, to health, and sustainability.

The comparative study first displays the results, including identified issues, from Munich, London, and results from the online Social Media Survey, followed by a conclusion at the end of this paper. The structure of subsequent, rather than parallel reporting is chosen as the events in London and Munich were not similar enough to be compared as identical. Significant differences were the materials used (e.g., a small demonstration model but no short video on a large screen in Munich vs. short video on a large screen but no demonstration model in London) as well as activities (part of “Engineering Family Festival” in London vs. sole stand in Munich).

2. The Citizen Participation Forum and the Social Media Survey “Revision Vertical Farming” at two museums

Citizen Participation Forum concept

The proposal of Cultivating Engagement was to construct the citizen participation forum as digital-physical process that is non-exclusive in its approach to participation. The citizen participation forum was staged in open public spaces and combined multimedia presentations of vertical farming with interactive software tools for public engagement and social research. In practice, the CPF combined interactions with visitors to science museums.
Research aims:

- understand how audiences with different relationships to food, health, science and technology relate to vertical farming
- use participatory methods to analyse visual representations of vertical farming on social media
- collect ethnographic observations concomitant to events to capture the quality and a more in-depth understanding of interactions between museum visitors and the Cultivating Engagement team

Venues: the Science Museum and the Deutsches Museum

We chose two science and technology museums as the public spaces in which to stage the citizen participation forum for several reasons. Both are internationally recognised institutions and have extensive historical collections that include many of the most important innovations in science and technology. Both museums have also served as settings for citizen participation and engagement with techno-scientific innovation. These museums therefore offer both open public spaces and provide a context in which social and ethical dimensions of vertical farming can be articulated and engaged with.

London’s Science Museum is widely recognised for its interactive and contemporary science exhibitions. Alongside its historical collections, the Museum has also been at the centre of science policy agendas from the 1990s, and the site of a range of experiments in citizen participation (i.e. the first "consensus conference" on plant genetics funded by the Biotechnology and Biological Sciences Research Council in 1995). Until recently, the Museum also had a centre for "public dialogue" that provided the setting for a range of engagement processes. The museum is free to visitors and its visitor base is comprised largely of family visitors and tourists.

The Deutsches Museum is the world’s largest museum of science and technology, and the largest museum in Munich. Founded in 1903, the Deutsches Museum also has relevance for being located in one of the leading high-tech and R&D hubs in Europe, i.e. Munich and surrounding areas, including the field of agriculture and food technologies. The museum has conducted numerous EU projects on science communication, public engagement and citizen participation. Currently, the Deutsches Museum is also revamping its permanent Agriculture exhibition. The setting is relevant for the citizen participation forum, as it attracts many visitors, not only from Munich but also tourists.

Issue analysis as a method applied in this study

When designing a participation process, problem framings can establish a basis for engagement. A mantra of many participation practitioners’ states: "no issue, no public!" Following scholarship in the field of science & technology studies, the methodology informing the proposed Citizen Participation Forum is based on the assumption that technology and society mutually shape each other. In other words, novel technologies do not simply ‘drop from the sky’ as ‘disruptive’ innovation but are developed through, and embedded in social processes and shared value systems. Hence, the issue-mapping approach is often designed for a given technology or technical practice considered to address a specific problem.

Such perspective requires that the problem-framings – the issues – that a technology claims to ‘solve’ are evident in public concerns. However, current debates of vertical farming and its ability to address specific
problems in a substantive way, e.g. soil depletion or water saving, as outlined by Despommier (2010), mostly take place among a small circle of scientists, entrepreneurs and advocates of VF. Mainstream media only superficially addresses these problems as generic issues, such as food security or climate change. As a result, in wider public debates, there are few grounded connections drawn between vertical farming and such problems. This means that in media coverage vertical farming is widely associated with a range of social and environmental challenges facing food systems, yet they are often treated in the abstract (climate change, food security, urban sustainability, etc.) or in very instrumental ways (e.g. VF as a "solution to urban food security").

The emphasis of the Citizen Participation Forum was therefore not to present VF as a "technical fix" to problems in food systems but rather to pay attention to the articulated issues – the concerns, hopes and questions – of participants. The "co-creation" of data visualisations through the Social Media Survey and the Social Media Map (DEL03) provide useful resources for understanding what issues drive discussions around VF, and could enable citizens as co-creators in subsequent projects to understand what is valuable in VF publicity. The methodology therefore aligns with co-creation approaches advocated at EIT Food, and aims to identify opportunities for citizens to drive innovation. Such analysis informs the development of participatory methods for EIT Food and beyond to engage citizens and shape the food issues that concern them. Issues identified in Munich and London are described in chapters 3.5.2., 3.6.2., 4.5.2. and 4.6.2.

The Social Media Survey

The Social Media Survey (abbreviated as SMS in the following) is a participatory social media research software designed for exploratory research about vertical farming. It was used as way of engaging visitors at the above-mentioned science/technology museums to engage conversations on issues they relate to vertical farming. Using Instagram's public API (application programming interface), the tool uses and displays a data set of 16,405 entries on vertical farming (hashtagged with #verticalfarming) from 2,500 users, from August 2011 to December 2017, along with associated metadata (including, likes, location, text, comments, hashtags, timestamps).

The tool is designed to elicit alternative visuals of vertical farming besides dominant images present in general internet searches (i.e. architectural renderings). It enables users to repurpose this data to create 'visions' of vertical farming: that is, novel associations between images in the data set. TUM researchers therefore named the tool “Re-vision Vertical Farming.” Participants can click through and select three images from a subset in form of a randomized chain of images out of the data set. Showing a subset of images is beneficial because it is impossible for a survey participant to view all available images. The reason for keeping the subset random and different for each participant was to avoid priming effects, and to keep participants’ associations free and open. Additionally, visitors were asked to self-identify how they relate to food, health, science and technology. The aim is to identify trends in how visitors with different relationships to food, health, science and technology relate to visual representations of vertical farming.

The Social Media Survey was used throughout all three days at the Deutsches Museum, and used on 1 ½ days at the Science Museum. The project partners also advertised it online, thus providing a third set of data (see below). TUM researchers subsequently analysed the metadata and combined this with qualitative data (participant observations) obtained during interactions with visitors. The online tool is available at http://revisionvf.org/
3. The event at the Deutsches Museum in Munich

This chapter provides an overview and analysis of survey results from the Social Media Survey (SMS) which was used during a citizen participation forum event at the Deutsches Museum in Munich, on July 5th-7th 2018. The amount of responses recorded is n=111, which is equivalent to 111 individual participants. The structure of the report follows the order of information and questions presented to survey participants in the SMS. The segmentation variables language, familiarity with vertical farming (abbreviated as VF in the following), attitude towards technology, influences on food decisions, age and residence are evaluated quantitatively. Selected images and comments about the images as well as comments about the meaning of VF (vertical farming) are evaluated qualitatively. A connection between segmentation variables and the qualitative evaluation of images and comments (by way of participant observation) is provided at the end of the report in a selection of five participants who are described as case examples. The report concludes with a summary of attitudes towards and associations with vertical farming.

3.1. The event at the Deutsches Museum

The data analysed in this report originates from the three-day citizen participation forum in the hall of honours (Ehrensaal) at the Deutsches Museum in Munich, Germany, from July 5th-7th 2018. During this event, museum visitors were invited to share their vision of vertical farming through images, and to discuss with us the future of local and sustainable food systems. The forum aimed to foster an open dialogue on new technologies in food production. The event was advertised publicly on Munich public transportation, the museum website, as well as through personalized emails to stakeholders. The below roll-up banner was displayed at the event.
The idea of vertical farming may sound futuristic. However, there are already several vertical farms operating in Japan, the United States, and Germany. Other countries have also started to invest in vertical farming as a way to address the issue of food security and sustainability. In the United States, companies like Gotham Greens and Chicago Sky are already operating vertical farms in urban areas.

**ADVANTAGES OF VERTICAL FARMING**
- Plants can grow independently from local weather and seasonality, as it happens indoors.
- The controlled environment allows for year-round production without the need for pesticides.
- Water and space are used more efficiently.
- In an urban context, food is grown locally, and food miles can be reduced.

**DISADVANTAGES OF VERTICAL FARMING**
- Energy needs for vertical farming are high, which can offset sustainability gains of the system.
- Due to high operational costs, end products may become expensive.
- Vertical farms require significant investments, including a small, high-tech facility.
- Creating the optimal environment for a plant is a complex process that vertical farms often undertake.

**WHY WOULD YOU THINK VERTICAL FARMING OFFERS FOOD FOR THOUGHT ABOUT OUR CURRENT FOOD SYSTEM?**

- Discussions about sustainability and resource management in the context of vertical farming.
- The potential for reducing food miles and improving local food production.
- The integration of advanced technology and urban agriculture.

**WHAT ARE YOUR THOUGHTS ON VERTICAL FARMING? HOW DO YOU SEE THE FUTURE OF FOOD?**

- Share your thoughts on how food production should look like, and participate in our re-visioning Vertical Farming talk!
3.2. **Participants’ responses: “Which language do you prefer?”**

“Welche Sprache bevorzugst Du?”

At the beginning of the survey, participants were asked which language they preferred for the survey to be displayed in. Out of the sample of n=111 respondents, 65 respondents selected German and 46 selected English.

3.3. **Participants’ responses: “Have you ever heard of Vertical Farming before?”**

“Hast Du schon einmal von Vertical Farming gehört?“

The answer options for the above-mentioned questions were:

- No, not at all.
- A little bit.
- Yes.

The above-mentioned question was only introduced on the second day of the event due to a technical error. This means that this question received 35 responses less than other survey questions. The 35 surveys not including this question were still used for the analysis of other questions. This means that for this question, the sample size was n = 76. The most frequent answer to the question about familiarity was slightly familiar (40 percent), followed by an equal number of familiarity with VF, and no familiarity at all (21 percent respectively; see Figure 1).

![Pie chart](image)

*Fig. 1: pie chart indicating familiarity with vertical farming (not including opinions of 35 survey participants from the first event day and the early morning of the second event day)*
3.4. **Participants’ responses: “Help us create a new vision of ‘Vertical Farming’! Select three images.”**

„Wie kann eine neue Vision von “Vertical Farming” aussehen? Suche drei Bilder aus.“

3.4.1. **Themes in selected images: food, technology, plants, people**

The 333 selected images were analysed according to the themes listed in the below Table 1. In some cases, several themes applied to one image. In these cases, all applicable themes were noted, rather than choosing only one theme per image.

The most popular concepts included in visions of VF are listed below in descending order of frequency:

- **Plants** (in terms of unpicked plants; mainly edible)
- **Plants stacked layers or shelves** (of plant cultivation; sometimes empty shelves)
- **Pink / purple light**
- **People** (mainly employees of farms)
- **Technology** (cables, LED lights, etc.)
- **Gardening or DIY ideas**
- **Buildings** (including architectural renderings)
- **Food** (picked plants; cooked or otherwise prepared food)

Table 1 lists the types of themes and their frequency:

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants (sum of all types of plants)</td>
<td>227</td>
</tr>
<tr>
<td>Plants: edible</td>
<td>182</td>
</tr>
<tr>
<td>Stacks or layers of plants (shelves / pillars / tubes / pyramids)</td>
<td>144</td>
</tr>
<tr>
<td>Pink / purple light</td>
<td>68</td>
</tr>
<tr>
<td>People (sum of all types of people)</td>
<td>65</td>
</tr>
<tr>
<td>Technology</td>
<td>63</td>
</tr>
<tr>
<td>People: farm worker / employee</td>
<td>44</td>
</tr>
<tr>
<td>Garden (or in some cases balcony or terrace)</td>
<td>44</td>
</tr>
<tr>
<td>Residential building and architectural renderings (sum of</td>
<td>37</td>
</tr>
<tr>
<td>Food (picked, cooked, packaged or prepared)</td>
<td>35</td>
</tr>
<tr>
<td>Yellow or white light</td>
<td>24</td>
</tr>
<tr>
<td>Plants: unclear / indistinguishable</td>
<td>21</td>
</tr>
<tr>
<td>Residential (mostly tall) building with plants as part of interior</td>
<td>17</td>
</tr>
<tr>
<td>Plants: decorative</td>
<td>13</td>
</tr>
<tr>
<td>Building: futuristic sketch</td>
<td>13</td>
</tr>
<tr>
<td>Empty shelves or empty plant pillars</td>
<td>13</td>
</tr>
<tr>
<td>People: unclear / indistinguishable (e.g. only hands visible)</td>
<td>11</td>
</tr>
<tr>
<td>Regular / conventional green house</td>
<td>11</td>
</tr>
<tr>
<td>People: private person</td>
<td>10</td>
</tr>
<tr>
<td>Close up shot of plant growing in sponge within vessel</td>
<td>8</td>
</tr>
<tr>
<td>Residential (mostly tall) building with plants on exterior</td>
<td>7</td>
</tr>
<tr>
<td>Plants: marihuana</td>
<td>6</td>
</tr>
<tr>
<td>Kitchen</td>
<td>5</td>
</tr>
<tr>
<td>Newspapers / magazines / news clipping</td>
<td>5</td>
</tr>
<tr>
<td>Quote, filling large part of image, highlighting benefit of VF</td>
<td>3</td>
</tr>
<tr>
<td>Education: VF in a school or university</td>
<td>3</td>
</tr>
<tr>
<td>Greenhouse with multiple floors</td>
<td>2</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Table 1: List of selected themes and their frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pet</td>
</tr>
<tr>
<td>Sketch of aquaponics or hydroponics</td>
</tr>
<tr>
<td>Forest</td>
</tr>
<tr>
<td>Soil filled vessel (only soil, no plant)</td>
</tr>
</tbody>
</table>

3.4.2. Examples of images

The below image examples illustrate the most popular themes in selected visuals in descending order of frequency: (stacked) plants, purple light, people, technology, gardens, and buildings.

Images including plants

The most popular image theme chosen was plants as a larger category, including the sum of all plant types or plant appearances (frequency: 227). Plant types included edible plants (frequency: 182) and plant appearances (in terms of how the plants were displayed) included stacked plants (frequency: 144), which can be seen in Image 1 below.

In many pictures, such as Image 1, three themes applied simultaneously: Firstly, plants (plants overall), secondly, edible plants and third, stacked plants. There were many different ways of stacking plants: e.g. in pillars (Image 1), shelves, tubes, or pyramids.

Plant types shown were in many cases lettuce (Image 1), herbs and microgreens. Other edible plants shown included tomatoes (Image 2) or berries (Image 7). Non-edible plants shown included decorative plants (Image 10).

Image 2: Example of stacked, edible plants visible in selected images. User account: agritecture
Image 3: Second example of edible plants visible in selected images. User account: cityhydro
Images including pink light and people

Besides plants (either stacked or not), pink/purple light and people (frequency: 68 and 65, respectively) were the second and third most common features in the chosen images. Most of the people depicted in these images were employees of vertical farms. Most of these employees wore casual clothing, like in Image 4. The image below shows an example of a selected visual including an employee, as well as an example of chosen visuals showing purple light.

*Image 4: example of pink light. User account: vffyyc*

*Image 5: example of people shown in selected images, as well as purple light visible. User account: verticalfarm.id*
Images including technology

Technology in the chosen images included lighting, cables or any other type of technology (frequency: 63). The theme “purple light” and “technology” are closely related, as purple light was often shown with the technology that operates lighting. This included particularly LED lighting or LED power systems (Image 6).

Image 6: Example of selected visual showing technology (power boxes and cables). User account: urbanizefarm

Image 7: Example of selected visual showing technology. User account: hortled
Images including gardens

Garden images (frequency: 44) focused on gardens in private homes, including DIY (Do-It-Yourself) ideas, as shown below.

*Image 8: Example of garden visible in selected visuals. User account: theplantcharmer*

*Image 9: Example of garden visible in selected visuals. User account: theplantcharmer*
Images including buildings

Residential building and architectural renderings (sum of subcategories) were also a popular choice (frequency: 37), though less frequent than other chosen categories. Often, buildings depicted in images were not just commercial plant factory buildings, but also residential buildings. In some cases, the buildings were shown as architectural renderings, like in the below image.

Image 10: Example of architectural rendering visible in selected images. User account: by2045

Image 11: Example of buildings visible in selected images. User account: dobrickenvironmental
Images including food

Food images included plants or food items that were picked, cooked, packaged or prepared (frequency: 35). The below images illustrate two types of food chosen. Image 12 could be considered to allude to VF’s claim towards healthy food, whereas Image 13 could be regarded to allude to a perception of VF as ‘trendy’ or ‘aesthetically appealing,’ which were associations noticeable in the analysis of comments.

Image 12: Example of selected visuals showing food. User account: good_bank

Image 13: Example of selected visuals showing food. User account: hydrovegan
3.4.3. User accounts connected to selected images

Out of 333 images selected, the 51 uploaders (user accounts) listed in the below Table 2 were selected more than once. The most popular user account was “theplantcharmer” with 27 selected images. The account “theplantcharmer” mainly posted images showing gardens.

<table>
<thead>
<tr>
<th>Uploader</th>
<th>Times selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theplantcharmer (gardens and DIY)</td>
<td>27</td>
</tr>
<tr>
<td>Zipgrow (farmer education)</td>
<td>14</td>
</tr>
<tr>
<td>javids2000 (hydroponics nutrients business)</td>
<td>12</td>
</tr>
<tr>
<td>Hydovegan (advocate of plant-based unprocessed food)</td>
<td>10</td>
</tr>
<tr>
<td>greencityfarms_ (account showcasing urban farming)</td>
<td>8</td>
</tr>
<tr>
<td>indmira</td>
<td>8</td>
</tr>
<tr>
<td>gronskastadsodling</td>
<td>5</td>
</tr>
<tr>
<td>nabugreens</td>
<td>5</td>
</tr>
<tr>
<td>agritecture</td>
<td>4</td>
</tr>
<tr>
<td>fibonacci_city</td>
<td>4</td>
</tr>
<tr>
<td>microvegetali</td>
<td>4</td>
</tr>
<tr>
<td>aerofarms</td>
<td>4</td>
</tr>
<tr>
<td>dobrickenvironment</td>
<td>3</td>
</tr>
<tr>
<td>freshboxfarms</td>
<td>3</td>
</tr>
<tr>
<td>futurafarms</td>
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<td>good_bank</td>
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<td>tc_thegardengal</td>
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<td>thecoolfarm</td>
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<td>urbanproduce</td>
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<tr>
<td>verticalfarm.id</td>
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<td>fazenda_urbana_brasil</td>
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<td>oplantfarms</td>
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<td>pyramid.garden</td>
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<td>sacsprouts</td>
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<tr>
<td>school_gardens_canada</td>
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<tr>
<td>thefireweedfactory</td>
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<tr>
<td>thinkdif</td>
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</tr>
<tr>
<td>towergardenofficial</td>
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<tr>
<td>upgrownfarmingco</td>
<td>2</td>
</tr>
<tr>
<td>verticalharvest</td>
<td>2</td>
</tr>
<tr>
<td>vertifarms</td>
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</tr>
</tbody>
</table>
3.5. **Participants’ responses: “I selected these images because...”**

„Ich habe diese Bilder ausgewählt, weil...“

3.5.1. **Overall attitude and popular topics**

When asked to describe why they chose particular images, survey respondents mentioned concepts that TUM researchers summed up in respective codes (see below, Table 4). The most frequent concepts that were mentioned were verticality, technology and future. In the comments, the general tone towards VF was neutral or positive. There was no negative attitude towards VF noticeable in comments accompanying selected images. In many conversations where visitors were more sceptical towards vertical farming, the project team also experienced greater openness once they explained vertical farming in more detail. This was for instance the case with two women who also partook in a brief film shooting for the Bavarian Broadcast BR that produced a short feature on vertical farming. However, there were also some experiences with visitors who had rather negative perspectives that would choose not to engage with the project team, as had been the case in some visitor interactions.

<table>
<thead>
<tr>
<th>Images: most common themes included in comments are listed below in descending order of frequency:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>Verticality</strong></td>
</tr>
<tr>
<td>• <strong>Technology</strong></td>
</tr>
<tr>
<td>• <strong>Future</strong>, or a futuristic way of speaking about VF</td>
</tr>
<tr>
<td>• <strong>Focus on food</strong></td>
</tr>
<tr>
<td>• <strong>Efficiency, general and spatial</strong>: Reduction of space or acreage (e.g. Stacking or layering of cultivation</td>
</tr>
<tr>
<td>• <strong>The colour Green</strong></td>
</tr>
</tbody>
</table>

**Explanation of themes**

Popular themes of the text entry section “I selected these images because...” („Ich habe diese Bilder ausgewählt, weil...“) are explained below using example comments.

- **Verticality**: Verticality was often mentioned as the most prominent or most relevant characteristic of this farming technique.
  - Example comment 1: „sie sich auf die vertikalen Möglichkeiten beziehen.”  
  **Translation**: “they refer to the vertical possibilities.”

---

1 The short feature was broadcasted on July 7th 2018. See https://www.br.de/mediathek/video/vertical-farming-senkrechter-pflanzenanbau-in-der-stadt-av:5b40daf9c7d5c10018269fab
- **Example comment 2:** “Vertikales Wachstum unter Einsparung von Fläche” *Translation:* “vertical growth with a reduction in acreage.

- **Technology:** Technology was often mentioned as a very relevant part of VF or even as a definition of VF. Technology was also connected to comments mentioning LED lighting.
  - **Example comment 1:** “Sieht nach Anwendung von Technologie im Landwirtschaftlichen Kontext aus” *Translation:* “Looks like the application of technology in agricultural contexts.”
  - **Example comment 2:** “my impression of vf is a highly technological one.”

- **Future:** The future was mentioned in terms of speaking about VF in a futuristic way, and emphasizing possibilities and opportunities rather than current situations. Using future tense grammatically rather than present tense was also part of the popular concept of future. Linked to this focus on the future was participants’ frequent tendency to refer to VF as “modern” or “new.”
  - **Example comment 1:** “These pictures make me think of the positive possibilities of Vertical Farming and the interesting Technology behind it”
  - **Example comment 2:** “A lot of People in Earth Need new Method [sic.] for their Food”

- **Food:** Participants also often focused on food in their comments (as opposed to medicine or decorative plants), e.g. through words like restaurant, kitchen, edible. This may be biased information, as the project team at the event presented vertical farming as primarily producing plants for food.
  - **Example comment 1:** “Look like Images of Otter [sic.] non traditional Farming : hydroponics, stacked, *Atlanta Vertical Garden for restaurant*”
  - **Example comment 2:** Nahrung, künstlich, in die Höhe” *Translation:* “Nutrition, artificial, upwards.”

- **Colour:** It was noteworthy that the colour green was mentioned multiple times. Indeed, it was mentioned more often than the colour purple, which is often associated with vertical farming (with respect to the often chosen red and blue light spectrum in LED lighting ). Participants therefore seemed to envision vertical farming, abstractly speaking, as a green coloured activity. Further, it was noteworthy that the topic of soil seemed to get no attention. What little attention it received was indirect, through comments on hydroponics or aquaponics (which imply a lack of soil). There was no valuation or criticism regarding soil or the lack thereof in VF.
  - **Example comment 1:** “Light led, [sic.] Green vegetable, in Building”
  - **Example comment 2:** “Sie sowohl grün sind, als auch das Verfahren zeigen” *Translation:* “They are green and show the process.”

- **Space-efficiency:** Further, participants emphasized the space-saving (or acre-saving) characteristic of VF.
  - **Example comment 1:** “Essbares wird angebaut. Platzsparender Anbau.” *Translation:* “Edibles are cultivated. Space-saving cultivation.”
  - **Example comment 2:** “Ersteres könnte man zu Hause machen Das zweite wäre sehr gut für die Industrie geeignet um sehr viel auf wenig Platz zu produzieren [sic.] Letzteres würde Gartenbesitzern sehr zu Gute kommen” *Translation:* “The first could be made at home. The
second would be suitable for the industry, to produce plenty on little space. The last would be beneficial for garden owners.”

- **Stacking / Layering:** Another popular concept was the reference to cultivation taking place stacked, or in layers (which is closely tied to the “verticality” characteristic).
  - Example comment 1: “vertical farming vom begriff her für mich nach gestapeltem anbau klingt” *Translation: “vertical farming, considering the term, sounds to me like stacked cultivation.”*
  - Example comment 2: “They depict plant growth layered vertically instead of spread out over a larger flat area.”

- **Health:** Participants mentioned human health and plant health three times, making “health” another moderately relevant concept.
  - Example comment 1: “I think that these images are related to vertical farm [sic.] because they invite people to assume a healthier way of life eating biological things”
  - Example comment 2: “The plants looked healthy.”

- **Environment:** Survey respondents referenced the environment or surrounding of VF several times, in terms of benefitting the (natural) environment, or discussing the (artificial) environment or space that creates VF (e.g. controlled environment). Therefore, VF was in part considered an artificial environment acting within or in harmony with the natural environment.
  - Example comment 1: “I think it is good for the Environment”
  - Example comment 2: “Good for Environment, Safe Space, democratization, everywhere, everyone”

### 3.5.2. Issues elicited from comments about image selection

<table>
<thead>
<tr>
<th>Issue</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verticality: emphasizing the vertical characteristic of VF.</td>
<td>12</td>
</tr>
<tr>
<td>Technology of VF. How much emphasis on this rather than the end product.</td>
<td>10</td>
</tr>
<tr>
<td>A futurist way of speaking about VF, or a focus on possibilities rather than facts</td>
<td>7</td>
</tr>
<tr>
<td>Appeal of, or focus on a certain food or food in general</td>
<td>6</td>
</tr>
<tr>
<td>Use of acreage (mainly in terms of a reduction of space used)</td>
<td>5</td>
</tr>
<tr>
<td>Focus on green colors (of plants)</td>
<td>5</td>
</tr>
<tr>
<td>Focus on stacking or layering in cultivation</td>
<td>5</td>
</tr>
<tr>
<td>Environment (how is this term used? Indoor? Outdoor? Controlled or contingent?)</td>
<td>4</td>
</tr>
<tr>
<td>Describing VF as modern or new</td>
<td>4</td>
</tr>
<tr>
<td>Urban agriculture, but also an idea of urbanism</td>
<td>4</td>
</tr>
<tr>
<td>“We feed the world” narrative. Anything related to this narrative.</td>
<td>4</td>
</tr>
<tr>
<td>Perception of VF as artificial</td>
<td>3</td>
</tr>
<tr>
<td>Controlled Farming: how do people frame controlled farming? Definition as</td>
<td>3</td>
</tr>
<tr>
<td>Euphoria related to Vertical Farming. What are the reasons? Is this just a temporary motivator? &quot;Attractiveness of Newness&quot;; includes any positive emotional reaction</td>
<td>3</td>
</tr>
<tr>
<td>Gardens, including references to DIY (Do It Yourself)</td>
<td>3</td>
</tr>
<tr>
<td>Purple light - discourse around purple light and vertical farming, the connection to lighting in growth more generally (pink, white, green light, etc.)</td>
<td>3</td>
</tr>
<tr>
<td>Focus on facts, or what is realistic or achievable (perhaps as opposed to futurist focus)</td>
<td>3</td>
</tr>
<tr>
<td>Large-scale production or economies of scale</td>
<td>3</td>
</tr>
<tr>
<td>Vegetables</td>
<td>3</td>
</tr>
</tbody>
</table>
Aesthetic appeal
Speaking of vertical farming as a resource-efficient farming method
Fruit
Greenhouse, as reference to VF
Reference to (human) health
Industries which are related to Vertical Farming, people with other industry backgrounds engaging in Vertical Farming
Nature and technology - what is considered a “natural” technology in food production and what “unnatural” technology? Is indoors considered unnatural per se, or the fact that VF can simulate other places, such as Southern Italy?
Production process - Which steps does it take to transform the raw material into the end product?

Table 3: Issues identified in images

3.6. Participants’ responses: “To me, Vertical Farming means...”

“Für mich bedeutet Vertical Farming...”

3.6.1. Overall attitude and identified issues

The most common issues in the described meanings of VF were space-efficiency, sustainability and efficiency in general. The attitude towards VF was positive or neutral in all comments discussing the general understanding of VF as a concept. There was no negative criticism towards VF in the comments of the social media survey. Further, the often-brief in-person interactions, and immediate invitations of visitors to partake in the SMS did not always allow enough time to engage in deeper discussions outside the social media survey. For some of the project team members, explaining to visitors briefly what vertical farming is often meant explaining its advantages, leaving little time to talk about wider issues and disadvantages as well. This is a similar observation made by project members at the TUM Open Day (see DEL07) where the invitation to conduct the survey would sometimes too abruptly stop an engaging conversation.

When asked to describe what vertical farming means to them, survey respondents mentioned themes the TUM researchers summed up in codes, as listed below in Table 5, and summed in most common issues.

<table>
<thead>
<tr>
<th>Meaning of VF: most themes included in comments about the meaning of VF are listed below in descending order of frequency:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>Efficiency, general and spatial</strong>: Reduction of space or acreage, VF as a resource-efficient farming method</td>
</tr>
<tr>
<td>• <strong>Sustainability</strong>, e.g. in terms of the carbon footprint</td>
</tr>
<tr>
<td>• <strong>Positive appeal of newness</strong></td>
</tr>
<tr>
<td>• <strong>Speculative future</strong>: A futurist way of speaking about VF; more focus on possibilities than scientific facts</td>
</tr>
<tr>
<td>• <strong>Verticality</strong></td>
</tr>
<tr>
<td>• <strong>Urban agriculture</strong> or ideas of urbanism</td>
</tr>
<tr>
<td>• <strong>Food, and promise to 'feed the world'</strong> (a focus on the potential of VF to feed a growing</td>
</tr>
</tbody>
</table>
Explanation of themes

Popular themes of the text entry section “To me, vertical farming means...” (“Für mich bedeutet Vertical Farming...”) are explained below using example comments.

- **Space efficiency**: One of the most popular associations was the space-efficiency, or reduction of acres used for VF compared to conventional farming.
  - Example comment 1: “A Space-saving farming technique for a growing population.”
  - Example comment 2: “Growing more on less Space.”

- **Sustainability**: Another popular association was the sustainability of vertical farming in terms of resource efficiency or environmental friendliness.
  - Example comment 1: “the future way os [sic.] sustainable farming.”
  - Example comment 2: “Städte und Architektur nachhaltig landwirtschaftlich nutzbar zu machen.” *Translation*: “Making cities and architecture sustainably useable for agriculture.”

- **Efficiency**: Linked to this association of sustainability was the popular emphasis on the efficiency of VF.
  - Example comment 1: “Vielleicht so viel wie lokal produzierte Produkte welche dann im Einzelhandel verkauft werden. Außerdem ist es meiner Meinung nach Platzsparender und -effizienter als normaler Anbau von Pflanzen.” *Translation*: “Perhaps locally produced products which are then sold in retail. Also, it is in my opinion more space saving and space efficient than normal cultivation of plants.”
  - Example comment 2: “A step in the right direction to protecting and conserving our planet’s natural resources while efficiently providing for a rapidly growing population.”

- **Food**:
  - Example comment 1: “High density Rapid growth of plant Foods in controlled indoor climate”

- **Positive emotion / motivation** (includes any positive reaction or positive valuation):
  - Example comment 1: In the case of this example, the respondent typed only one single word to define VF: “Progress.”
  - Example comment 2: “Logischer nächster Schritt.” *Translation*: “Logical next step.” Although logic is not emotion, this comment nonetheless represents a positive valuation or motivated attitude towards VF.
• A focus on the future
  o Example comment 1: “Wissenschaft, Labor, Biologie in ihren anfängen [sic.] mit großer Bedeutung Zukunft.” Translation: “Science; laboratory; nascent biology with great significance for the future.”
  o Example comment 2: In the case of this comment, the respondent typed only one single word to define VF: “Die Zukunft.” Translation: “The future.”

• Verticality
  o Example comment 1: “Vertikal = senkrecht , also müssen die Pflanzen auf den Bildern in irgendeiner Form die Höhendimension nutzensiehe [sic.]” Translation: “vertical = upright, so the plants in the pictures must somehow use the height dimension.”
  o Example comment 2: “Pflanzen die an einem Vertikalen Gegenstand wachsen, hält nicht horizontal. Also weg vom Boden.” Translation: “Plants which grow on a vertical item; not horizontal; so, away from the ground.”

• Urbanism
  o Example comment 1: “safe vegetables, city environment, [sic.]”
  o Example comment 2: “Symbiose von Architektur und Landwirtschaft im urbanen Raum.” Translation: “Symbiosis of architecture and agriculture in urban space.”

• A conviction of being able to feed a growing world population
  o Example comment 1: “A possible solution for mass Production of Food to satisfy the growing population.”
  o Example comment 2: “die zukünftige Ernährung der Weltbevölkerung” Translation: “The future nutrition of the world population.”

• Technology
  o Example comment 1: “Das Anbauen von Salat in de [sic.] Höhe. Und mit der Hilfe von Techni [sic.] und Technologie.” Translation: “The cultivation of lettuce upwards. And with the help of engineering (or techniques) and technology.”
  o Example comment 2: In the case of this comment, the respondent typed only one single word to define VF: “Technologie” Translation: “Technology”

• Newness or modernity
  o Example comment 1: “neue Ideen zur Anpflanzung [sic.]” Translation: “New ideas for cultivation.”
  o Example comment 2: “Eine neue Idee erforschen. Es sollte definitiv weiter erforscht werden.” Translation: “Researching a new idea. It should definitely be researched further.”

3.6.2. Issues elicited from comments about the meaning of vertical farming

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of acreage (mainly in terms of a reduction of space used)</td>
<td>19</td>
</tr>
<tr>
<td>Discussing vf in terms of sustainability (e.g. carbon footprint)</td>
<td>19</td>
</tr>
<tr>
<td>Speaking of vertical farming as a resource-efficient farming method</td>
<td>16</td>
</tr>
<tr>
<td>Appeal of or focus on a certain food or food in general</td>
<td>13</td>
</tr>
</tbody>
</table>
3.7. Participants’ responses: “How important is technological innovation for the future of food?”

“Wie wichtig ist technologische Innovation für die Zukunft der Nahrung?”

The answer options for the above-mentioned questions were:

- Very important
- Important
- Neither important, nor unimportant
- Unimportant
- Very unimportant
The most frequent answer to the above-mentioned question was “very important” with 49 per cent, as the below Figure 2 shows.

![Pie chart showing importance of technology for the future of food](image)

**Fig. 2**: pie chart indicating the importance of technology for the future of food (n=111; applies to all below graphs for the Deutsches Museum data).

### 3.8. Participants’ responses: “What influences the decisions you make about food? Select up to three from the below options.”

„Was beeinflusst die Entscheidungen, die Du zur Ernährung triffst? Wähle bis zu drei der Optionen.“

The answer options for the above-mentioned questions were:

- Nutritional value
- Grown locally
- Price of food item
- Organic production
- Grown outdoors
- Ethical business practices
- Other

The survey was designed in such a way that respondents could choose up to three influences on food decisions out of a selection of seven (one of which was unspecified and open for any comment, named “other”). Decision influences are listed below with the share in percentage of their selection in descending frequency. Concerning the amount of respondents, 35 individuals that participated in the overall study did not answer this particular question. The below percentages therefore apply to the 76 individuals that did answer this question.

Concerning familiarity with vertical farming, the popularity of the influences on food was as follows (in descending order of frequency for each category):

For the 16 individuals reporting they were familiar with vertical farming:

- Locality (selected 11 times)
- Nutrition and organic labelling (each selected 8 times)
- Ethical reasons (selected 4 times)
- Outdoor cultivation (selected once)
For the 44 individuals reporting they were slightly familiar with vertical farming:

- Organic labelling (selected 25 times)
- Locality (selected 19 times)
- Nutrition (selected 15 times)
- Ethical reasons (selected 11 times)
- Outdoor cultivation (selected 3 times)

For the 16 individuals reporting they were not familiar with vertical farming:

- Locality (selected 10 times)
- Organic labelling (selected 9 times)
- Nutrition (selected 6 times)
- Ethical reasons (selected 5 times)
- Outdoor cultivation (selected 3 times)

**Locality**

The most frequently selected influence on food decisions was locality. A slight majority (56 percent) of respondents indicated that locality was among the criteria that mattered most to their decisions about food, as Fig. 3 shows.

![Fig. 3: pie chart indicating whether locality is pivotal for decisions about food (n=76)](image)

**Organic sourcing**

The second most frequently selected influence on food decisions was organic sourcing. Opinions on the importance of food being organic were split equally in two: 50 % of respondents indicated that organic plant cultivation mattered most to their food decisions, 50 % indicated that this criterion was not among the most important influences for them.

![Fig. 4: pie chart indicating whether organic cultivation is pivotal for decisions about food (n=76)](image)
Nutrition

The third most frequently selected influence on food decisions was nutrition. 41 percent of respondents indicated that nutrition was among the most important decision criteria. Most survey respondents (59 percent) indicated that nutrition was not one of the most important influences on their decisions about food.

![Fig. 5: pie chart indicating whether nutrition is pivotal for decisions about food (n=76)](image)

Ethical reasons

A somewhat unpopular influence on food decisions was ethical reasons. The majority of respondents (74 percent) indicated that ethical reasons were not among the three most important influences for their decisions about food.

![Fig. 6: pie chart indicating whether ethical criteria are pivotal for decisions about food (n=76)](image)

Cultivation outdoors

The least popular influence on food decisions was cultivation outdoors. The clear majority (89 percent) of survey respondents indicated that whether or not food was cultivated outdoors was not a pivotal influence for them.

![Fig. 7: pie chart indicating whether outdoor cultivation is pivotal for decisions about food (n=76)](image)

Other / miscellaneous influence on food
Seven (out of 111) survey respondents specified individual influences on their food decisions that they felt did not belong to the survey’s predetermined influence categories. These influences were:

- **Appearance of food**
- **Energy** consumption required for production (participant reported slight familiarity with VF)
- **Meat avoidance** (familiarity with VF not specified)
- “**mix between taste, price and nutrition**” (no familiarity with VF)
- **Parents’ opinion** (13-year-old respondent) (no familiarity with VF)
- **Taste** (familiarity with VF not specified)
- **Quality** (familiarity with VF)

### 3.9. Participants’ responses: “Optional: How old are you?”

“Optional: Wie alt bist Du?”

Most participants did not indicate their age. From the responses indicating age, the average age is 35. The median age (which is not skewed by outliers) is 33.5.

![Fig. 8: pie chart indicating age](image)

### 3.10. Participants’ responses: “Optional: Where do you live?”

Optional: Wo wohnst Du?

Of the respondents that indicated their residence, most indicated Germany (42 per cent of all respondents). The second most frequent residence was the U.S.A. with six per cent. In total, respondents resided in 18 different countries (not including those who did not indicate residence). All residences can be seen in the below Figure 9.
3.11. Individual cases: Connections between comments, images, and segmentation variables

This section analyses connections between comments, images and the segmentation variables age, familiarity, technology, nationality, and influences on decisions about food. The focus is on five individual respondents as cases. The five case individuals were selected due to their noteworthiness in terms of interesting or elaborate comments, the top or bottom end of a spectrum, or other noteworthy features.

Case 1: Images and comments relating to age

Individual No. 1, with the highest indicated age of 75, focused on the simplicity and appeal of introducing VF or transitioning from conventional farming to VF. Individual No. 1 indicated a postal code, but no country (Bonn, Germany, or Wisconsin, USA). However, the person used English as preferred language. The selected images featured food, as well as a picture of farmers harvesting on a conventional field. This individual described technological innovation as very important for the future of food.

Case 2: Images and comments relating to familiarity with VF

Individual No. 2 indicated an age of 55 and residence in Germany. This individual reported to be completely unfamiliar with VF but nonetheless provided much information about VF in his/her comments speaking about space efficiency, reduction of transportation and food security. The images chosen by this individual included food (picked cauliflower), pillars of plant cultivation in a residential apartment, and lettuce growing under pink light in what appears to be commercial cultivation.

Case 3: Images and comments relating to attitude towards technology

Individual No. 3 was the only individual to describe the importance of technology for the future of food as very unimportant. Interestingly, this individual limited his/her description of VF to high-tech farming (direct quote from comment: “high-tech farming.” - no other information within this comment section),
which stands opposed to the attitude towards technology. This individual indicated an age of 37 and a residence in Germany. The individual noted in his/her comments that VF would only be an option if sun-based farming was impossible. This individual stands out in the responses because the majority of noticeable attitudes towards VF and towards technology is positive. Although this individual might not have a negative stance towards VF, it could be considered neutral or sceptical. The images selected by this individual showed plants growing under pink light in shelves, hands in rubber gloves holding soil-less cubes of plants, and an employee adjusting a pillar of plants in what seems to be a green house.

**Case 4: Images and comments relating to residence**

Individual No. 4 stated residence in Germany and an age of 21. His or her comments were unique compared to other respondents in addressing moral and ethical considerations:

Ich habe diese Bilder ausgewählt, weil: “Sie zeigen, dass die Gesellschaft weiter forschen muss um aktuelle und zukünftige Probleme lösen zu können. Technik sollte positiv genutzt werden um gegen z.b. [sic] Ernährungsprobleme zu kämpfen.”

*Translation:* I selected these images because: “They show that society must keep researching to solve current and future problems. Technology should be used in a positive way to combat e.g. food problems.”


*Translation:* To me, vertical farming means: „The development of new technologies, improvement of life quality and a balancing act between ethical and moral questions and attitudes.”

The images chosen by this individual showed plants growing in plastic containers under pink light, as well as an architectural rendering.

**Case 5: Images and comments relating to influences on decisions about food**

Individual No. 5 has a noteworthy perspective in terms of decisions about food. The individual indicated only two factors as important for his/her decisions about food, even though a selection of three categories would have been possible. The chosen influences were nutrition, and “other: energy consumption required for production”.

The influence of energy consumption is interesting considering the currently high energy use of vertical farms. However, the comment about energy consumption could also refer to energy used in the long transportation paths of conventionally farmed food. This individual indicated an age of 20 and residence in the USA. The images selected by this individual showed plants growing stacked or in layers in open spaces (a garden and an exposed field) and in what appears to be a DIY or residential greenhouse.

### 3.12. Impressions from interactions with Munich’s museum visitors (field notes)

The staff of the citizen participation event recorded noteworthy interactions in field notes. These field notes provide a deeper and more open understanding of citizens’ reactions and ideas regarding VF.
Thereby, the notes represent a complement to the above data collected in the SMS. A summary of interactions with study participants is presented in this section.

Generally, museum visitors at the Deutsches Museum reported to have a vague notion of what VF is, and it was perceived to be a rather unknown concept in detail. Consequently, most associations were quite abstract.

Overall, participants emphasized the advantages of VF in conversations. Participants in this context also frequently mentioned their willingness to consume vertically farmed products. The ideas and comments discussed with event staff generally intersected with the issues elicited in participants’ responses to the Social Media Survey, which makes sense considering that many participants would not express the same comments in writing as they do orally. The following positive associations or issues with VF were recorded in conversations:

**Interactions**: most common positive themes included in interactions are listed below:

- **Absence of pesticides** (the most popular association raised in conversation)
- **Efficiency**: Reduction of used space
- ‘**Feeding the world**’: Opportunity to feed a growing world population
- **Self-sufficiency** in terms of DIY (Do-It-Yourself) home-grown food
- **Local food production**: Ability to grow locally, thereby reducing transportation and increasing freshness
- **Water saving** potential
- **Climatic and weather independence**
- Potential to **reduce fertilizer use**
Negative associations with VF recorded in conversations were the following.

**Interactions: most common negative themes included in interactions are listed below:**

- **Skepticism towards technologization:** The high-tech perception of VF was seen mainly favourably, but also neutral (one German participant commented “There will be skyscrapers and robots.”) and negative (another German participant called VF “technifiziert”; translation: “technified”, indicating a negative connotation).
- **Energy use:** The use of energy was seen as a slight but not impeding disadvantage, due to the ability to fall back onto reusable energy.
- **Correlation to GMOs, and multinational corporativism:** The connection of personalized food or nutrient optimization with genetically modified (GMO) food, leading to a connection to Bayer and Monsanto, which in turn was perceived to be a negative association with VF.
- **Labels:** The confusion around labels, specifically labels of origin and labels of organic cultivation, with potential labels indicating VF on retail products.
- **Lack of soil:** For three participants, the lack of soil and the closed environment was perceived as negative in conversations (in the words of a Mexican couple: plants need “sun and soil”.)

### 3.13. Conclusion for citizen participation in Munich

The overall attitude towards vertical farming in comments was neutral or often positive. As mentioned above, the factor needs to be considered that in any survey on a specific topic people disagree with they may opt not to partake at all. It is possible that museum visitors who may have been critical towards VF might have avoided engaging with the event staff. Further, with a rather unknown concept like vertical farming, explaining vertical farming in quick face-to-face interactions with (i.e. not taking the time to read the posters) posed a challenge: explaining what vertical farming is often meant explaining (only) its advantages, leaving little to no time to talk about disadvantages. It is recommended for the training of the staff to not only explain the advantages of VF while engaging with visitors. One could also ask about disadvantages or ask about their fair opinion on a chosen matter.

Interestingly, respondents choose different ways of visualizing and describing vertical farming. What vertical farming means was expressed differently as visual than it was expressed as comment about the visual. This in turn was different to how it was expressed as a comment about the meaning of vertical farming more generally.

The images which survey respondents selected to envision VF mainly included stacked, edible plants, often under purple light (including the technology needed to operate it), and often with farm employees displaying or caring for the plants. Besides these commercial representations, VF was also implied to be part of private life, e.g. by being displayed in gardens, as part of residential buildings, and as ready-to-eat food.
When asked to describe why they had chosen the images with the above concepts, participants focused on verticality (which is connected to the stacking or layering of plants), technology, the colour green, as well as the benefits of VF in terms of being a progressive, future-oriented farming method that would save space and provide food.

Interestingly, the colour green was mentioned more often in comments than the colour purple, and thus presents a contrast to images displayed in the internet when searching for the term “vertical farming”. This could indicate that participants are not fully or consciously aware of the association of the colour purple with VF, and/or instead consciously focus more on the colour green typically or more commonly associated with plant growth.

When asked to describe what VF means, participants focused on the benefits of VF, particularly sustainability including a reduction of used acreage as well as resource-efficiency and food-security. Further, how humans live or should live together, in terms of ideas of urbanism and future, were a popular focus. Overall, comments about the meaning of VF were positive and even idealistic (e.g. in terms of the narrative of being able to feed the world).

In sum of all visions and comments from Munich, a strong interest of participants could be considered to be the (1) vertical and urban appearance of the farming method as buildings and within or adjacent to buildings, the (2) significant role technology plays in VF, a (3) focus on food, and a (4) focus on the future in terms of seeing VF as a solution to current problems or an otherwise attractive future.
4. The event at the Science Museum in London

4.1. The event at the Science Museum

The citizen participation event at the Science Museum in London lasted three days from October 24th – 26th 2018. It took place during the “We Are Engineers Family Festival” with the title “Going Vertical.” To accommodate this family element, the event staff offered a children’s activity, which included drawing vertical farms on postcards. At this event, 115 adults participated in the Social Media Survey. Most of these individuals were parents who were waiting for their children to finish the afore-mentioned drawing activity. The location within the museum was in a basement area dedicated to temporary family activities. Used displays and materials comprised three roll-up banners, and four large tables with postcards, felt-tipped pens and coloured pencils. Approximately seven iPads were used by staff to collect the Social Media Survey results.

Different to the event at the Deutsches Museum, project partner PlantLab tested a different communication model by showing a short video on vertical farming as done at PlantLab as there was not enough space available to bring the same communication model as in Munich. It was produced by EUFIC for the consumer research studies (DELO6) and was displayed on one large TV monitor.

To avoid biased opinions in the Social Media Survey, it was decided to not run the 2 surveys in parallel. Therefore PlantLab tested a survey on the first 1 ½ day and TUM conducted the Social Media Survey the other half of the time (1 ½ day). The below roll-up banner was displayed by TUM at the London event.
HOW WE CAN GROW CROPS IN CITIES

Have you ever heard of Vertical Farming?

Vertical farming describes an approach where laboratory technologies are repurposed for food production. Growing conditions of plants (e.g., water, temperature, light) are closely monitored and regulated.

Vertical farming is a form of “Controlled Environment Agriculture” (CEA) besides the more well-known greenhouse. In the urban context, vertical farms can reduce food miles, and plants are grown in vertically stacked layers to maximise use of space.

Vertical farming is also connected to non-food-related industries, from plant-based ingredients for micro-nutrients to plant research more generally.

Currently, most vertical farms produce fresh goods that easily perish after long hauls, such as leafy greens, tomatoes and herbs.

WHY VERTICAL FARMING?

With debates on the inefficiency of the current food system, vertical farming is one of many approaches to address these issues. Its potential lies in the combination of existing technologies in horticulture, agriculture and plant science with recent advances in computation, LED light and energy technologies.

ADVANTAGES

In vertical farms, plants can grow independent from seasons, local weather, water and space are used more efficiently, and its controlled growing environment creates conditions in which pesticides are not needed.

Urban vertical farms grow food locally which helps reduce food miles and greenhouse gas emissions.

LIMITATIONS

But vertical farms aren’t perfect. They require a lot of energy for maintenance, and have high operation costs which can make their end-products expensive. There is currently a limited crop variety, only growing plants like leafy greens and herbs.

Creating the optimal growing conditions is complex, something that VF start-ups often underestimate.

Image 14: Roll-up banner displayed at the Science Museum (created by EUFIC and TUM) on the general aspects of VF.
4.2. Participants’ responses: “Which language do you prefer?”

At the beginning of the survey, participants were asked which language they preferred for the survey to be displayed in. Out of the sample of n=115 adult respondents, two respondents selected German and 113 selected English. 37 participants used the children’s version.

4.3. Participants’ responses: “Have you ever heard of Vertical Farming before?”

The answer options for the above-mentioned questions were:

- No, not at all.
- A little bit.
- Yes.

The most frequent answer to the question about familiarity was not familiar (49 percent), followed by slight familiar with VF (35 percent). Familiar was quite clearly the least frequent answer (16 percent).

![Fig. 10: pie chart indicating familiarity with vertical farming](image)

4.4. Participants’ responses: “Help us create a new vision of ‘Vertical Farming’! Select three images.”

4.4.1. Themes in selected images: plants, light, technology, people

The 345 images selected by adults were analysed according to the themes listed in the below Table 5. In some cases, multiple themes applied to one image. In these cases, all applicable themes were noted, rather than choosing only one theme per image.
Children: Similar to adults, images selected by children in the reduced child-friendly version (which included image selection but no written questions) of the survey mainly depicted edible plants, pink light, buildings, people, nature and food. A noteworthy difference compared to adults was that children selected food and nature (country sides, flowers) much more often, and technology much less often. The children’s’ images were not included in the below frequency of adults’ selected themes, so results would not be distorted.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants (sum of all types of plants, in some case multiple categories apply, e.g. &quot;stacked&quot; and &quot;edible&quot;)</td>
<td>350</td>
</tr>
<tr>
<td>Plants: edible (in most cases tomatoes, lettuce or herbs)</td>
<td>148</td>
</tr>
<tr>
<td>Plants: Stacks or layers of plants (shelves / pillars / tubes / pyramids)</td>
<td>139</td>
</tr>
<tr>
<td>People (sum of all types of people)</td>
<td>70</td>
</tr>
<tr>
<td>Light: Pink / purple light</td>
<td>62</td>
</tr>
<tr>
<td>Technology</td>
<td>53</td>
</tr>
<tr>
<td>People: farm worker / employee</td>
<td>44</td>
</tr>
<tr>
<td>Light: Yellow or white light</td>
<td>43</td>
</tr>
<tr>
<td>Garden (or in some cases balcony or terrace)</td>
<td>33</td>
</tr>
<tr>
<td>Plants: unclear / indistinguishable</td>
<td>32</td>
</tr>
<tr>
<td>Buildings: Residential building or building sketch (sum of subcategories, not including greenhouses)</td>
<td>26</td>
</tr>
<tr>
<td>Greenhouse</td>
<td>21</td>
</tr>
<tr>
<td>Seeds, seedlings or microgreens</td>
<td>17</td>
</tr>
<tr>
<td>Food (picked, cooked, packaged or prepared)</td>
<td>16</td>
</tr>
<tr>
<td>People: unclear / indistinguishable (e.g. only hands visible)</td>
<td>14</td>
</tr>
<tr>
<td>People: private person</td>
<td>12</td>
</tr>
<tr>
<td>Plants: decorative</td>
<td>10</td>
</tr>
<tr>
<td>Buildings: Residential (mostly tall) - plants on exterior</td>
<td>10</td>
</tr>
<tr>
<td>Building: futuristic sketch</td>
<td>9</td>
</tr>
<tr>
<td>Synthetic soil or roots in water</td>
<td>9</td>
</tr>
<tr>
<td>Buildings: Residential (mostly tall) - plants as part of interior</td>
<td>7</td>
</tr>
<tr>
<td>Plants: marihuana</td>
<td>4</td>
</tr>
<tr>
<td>Countrysides / &quot;nature&quot;: mountains, wild flowers, park</td>
<td>4</td>
</tr>
<tr>
<td>Empty shelves or empty plant pillars</td>
<td>2</td>
</tr>
<tr>
<td>Conference / presenter</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 5: types of themes and their frequency.
4.4.2. Examples of images

Examples of popular visuals are the following. Most of the below images include several categories at once, which is why some categories (e.g. plants) are not listed with separate examples.

4.4.2.1. Images including plants, pink light and white light

Image 15: Example of edible plants and white light. User account: dianeesvan

Image 16: Example of people and (most dominantly) pink light. User account: farm_urban
Images including technology

Image 17: Example of technology (lighting, fan, cables, and power switch). User account: traction.video / Metropolis Farms

Image 18: Example of technology (growth lighting). User account: pl_light
Images including plants, people, and pink light

Image 19: Example of stacked plants and people (most likely employees). User account: vertical harvest

Image 20: Example of stacked plants, pink light, technology (power box) and people (employees and consumers). User account: socialinnovationnetwork
Images including stacked plants, garden and greenhouse

Image 21: Example of stacked plants in a garden. User account: gogrowplanters

Image 22: Example of stacked plants in a greenhouse. User account: towergardenofficial
**4.4.3. User accounts connected to selected images**

Out of the 345 images selected, the 19 uploaders (user accounts) listed in the below Table 6 were selected more than once. The most popular user account was “hydrovegan” with 10 selected images. This account mainly posted images showing fruit and vegetables, often with people as part of the picture.

<table>
<thead>
<tr>
<th>User accounts</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrovegan</td>
<td>10</td>
</tr>
<tr>
<td>theplantcharmer</td>
<td>6</td>
</tr>
<tr>
<td>zipgrow</td>
<td>6</td>
</tr>
<tr>
<td>greencityfarms_</td>
<td>4</td>
</tr>
<tr>
<td>freightfarms</td>
<td>3</td>
</tr>
<tr>
<td>indmira</td>
<td>3</td>
</tr>
<tr>
<td>chigginstraveler</td>
<td>2</td>
</tr>
<tr>
<td>drjroberti</td>
<td>2</td>
</tr>
<tr>
<td>easyrecipeyoulove</td>
<td>2</td>
</tr>
<tr>
<td>feedourcities</td>
<td>2</td>
</tr>
<tr>
<td>freshboxfarms</td>
<td>2</td>
</tr>
<tr>
<td>gardeningtipsok</td>
<td>2</td>
</tr>
<tr>
<td>gronskastadsodling</td>
<td>2</td>
</tr>
<tr>
<td>javids2000</td>
<td>2</td>
</tr>
<tr>
<td>mycopiamushrooms</td>
<td>2</td>
</tr>
<tr>
<td>nordamark</td>
<td>2</td>
</tr>
<tr>
<td>rexdesignconcepts</td>
<td>2</td>
</tr>
<tr>
<td>stackedfarm</td>
<td>2</td>
</tr>
<tr>
<td>zackoutside</td>
<td>2</td>
</tr>
</tbody>
</table>

*Table 6: User accounts selected more than once*

**4.5. Participants’ responses: “I selected these images because...”**

**4.5.1. Overall attitude and popular topics**

The most common concepts in the descriptions of image selection were verticality, indoor-cultivation and artificial light. The attitude towards VF was positive or neutral. There was no negative criticism towards VF in image descriptions. The most popular concepts included in these comments are listed below in descending order of frequency:

*Images: most common themes included in comments are listed below in descending order of frequency:*

- **Verticality**
- **Indoor-cultivation**
- **Light**: artificial light / absence of natural sunlight
- **Technology**
- **Space-efficiency**: reduction of used acres
- **Aesthetic appeal**
Examples of themes

Popular themes of the text entry section “I selected these images because...” are explained below using example comments. In some cases, several themes applied to one comment.

- **Verticality**
  - Example comment 1: “Vertical”
  - Example comment 2: “Things that grow up above ground with the help of technology”

- **Indoor-cultivation**
  - Example comment 1: “They are mainly indoors”
  - Example comment 2: They Show plants being grown on a large scale indoors

- **Light: artificial light / absence of natural sunlight**
  - Example comment 1: “these don’t rely on sunlight and are stacked up. They use led lights.”
  - Example comment 2: “They expressed plants growing inside with artificial light”

- **Technology**
  - Example comment 1: “They Look like they could be Vertical Farming TECHNOLOGY”
  - Example comment 2: “They seem to be high tech farm setups”

- **Space-efficiency / reduction of used acres**
  - Example comment 1: “save space.”
  - Example comment 2: “Make use of space”

- **Aesthetic appeal**
  - Example comment 1: “They are interesting and thought provoking and beautiful”
  - Example comment 2: “They Look healthy & attractive”

- **Large-scale food production**
  - Example comment 1: “Demonstrate mass production, technology and natural products”
  - Example comment 2: “They Show plants being grown on a large scale indoors”

- **Future or possibilities**
  - Example comment 1: “I believe This is the way the Future is going”
  - Example comment 2: “These highlight the scale of what could be achieved”

### 4.5.2. Issues elicited from comments about image selection

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verticality: emphasizing the vertical characteristic of VF.</td>
<td>9</td>
</tr>
<tr>
<td>Cultivation indoors</td>
<td>8</td>
</tr>
<tr>
<td>Purple light - discourse around purple light and vertical farming, as well as the connection to lighting in growth more generally (pink, white, green light, sunlight etc.)</td>
<td>7</td>
</tr>
<tr>
<td>Technology of VF. How much emphasis on this rather than the end product. Includes description of vertical farms as factories</td>
<td>6</td>
</tr>
<tr>
<td>Use of acreage (mainly in terms of a reduction of space used)</td>
<td>5</td>
</tr>
<tr>
<td>Aesthetic appeal</td>
<td>5</td>
</tr>
<tr>
<td>Large-scale or increase in food production, including economies of scale</td>
<td>5</td>
</tr>
</tbody>
</table>
A futurist way of speaking about VF, or a focus on possibilities rather than facts 4
Describing VF as modern, new or unconventional 3
Speaking of vertical farming as a resource-efficient farming method 3
Appeal of or focus on a certain food or food in general 3
Focus on green colors (of plants) 3
Perception of VF as natural, and its products as natural food 3
Controlled Farming: how do people frame controlled farming? Definition as “environment” 2
Describing VF as a domestic activity / for home use 2
Gardens, including references to DIY (Do It Yourself) 2
Reference to (human) health 2
Focus on stacking or layering in cultivation 2
Describing VF as clinical, sterile or industrial 2
“We feed the world” narrative. Anything related to this narrative. 2

Table 6: Issues elicited from comments relating to images

4.6. Participants’ responses: “To me, Vertical Farming means...”

4.6.1. Overall attitude and popular topics

When asked to describe the meaning of VF, the most frequent themes that were mentioned in London were space-efficiency or a reduction of used acres (mentioned 20 times), indoor-cultivation (mentioned 12 times), and resource-efficiency (mentioned 11 times). In the comments, the general tone towards VF was mainly neutral or positive. A negative attitude towards VF was noticeable in very few comments accompanying selected images with implied negative connotations, such as “a bit fake” or “cheap mass production”.

The most common themes and associations included in comments about the meaning of VF during the event in London are listed below in descending order of frequency:

Meaning of VF: most common themes included in comments are listed below in descending order of frequency:

• Efficiency, general and spatial: space-efficiency, reduction of used acres, and resource efficiency
• Indoor cultivation
• Verticality
• Artificialness or “unnaturalness” of VF
• Sustainability
• Lighting (pink light, absence of sunlight)

Explanation of themes

Popular themes of the text entry section “I selected these images because...” are explained below using example comments. Often, several themes applied to one comment.
• **Space-efficiency or a reduction of used acres**
  o Example comment 1: “Farming more efficiently in less space using less water”
  o Example comment 2: “Space saving.”

• **Resource-efficiency**
  o Example comment 1: “Farming more efficiently in less space using less water”
  o Example comment 2: “Sustainable efficient and productive”

• **Indoor-cultivation**
  o Example comment 1: “Indoor farming”
  o Example comment 2: “Plants being grown indoors without sunlight”

• **Verticality**
  o Example comment 1: “Farming vertically and saving space”
  o Example comment 2: “farming going up”

• **Artificialness or "unnaturalness" of VF**
  o Example comment 1: “Artificial Farming without the use of sun or Natural fields”
  o Example comment 2: “Growing in unnatural conditions”

• **Sustainability**
  o Example comment 1: “Sustainability and ecological sound”
  o Example comment 2: “An innovative way for everyone to get involved in sustainable farming.”

• **Discussion of lighting (pink light, absence of sunlight)**
  o Example comment 1: “Not Natural as there is no sunlight.”
  o Example comment 2: “Growing plants indoors using artificial light and less space”

### 4.6.2. Issues elicited from comments about the meaning of vertical farming

<table>
<thead>
<tr>
<th>Issue</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of acreage (mainly in terms of a reduction of space used)</td>
<td>20</td>
</tr>
<tr>
<td>Cultivation indoors</td>
<td>12</td>
</tr>
<tr>
<td>Speaking of vertical farming as a resource-efficient farming method</td>
<td>11</td>
</tr>
<tr>
<td>Verticality: emphasizing the vertical characteristic of VF.</td>
<td>10</td>
</tr>
<tr>
<td>Perception of VF as artificial, unnatural or &quot;human intervention&quot;</td>
<td>8</td>
</tr>
<tr>
<td>Discussing VF in terms of sustainability (e.g., carbon footprint)</td>
<td>7</td>
</tr>
<tr>
<td>Purple light - discourse around purple light and vertical farming, as well as the connection to lighting in growth more generally (pink, white, green light, sunlight etc.)</td>
<td>6</td>
</tr>
<tr>
<td>Large-scale or increase in food production, including economies of scale</td>
<td>5</td>
</tr>
<tr>
<td>Describing VF as modern, new or unconventional</td>
<td>4</td>
</tr>
<tr>
<td>Technology of VF. How much emphasis on this rather than the end product. Includes description of vertical farms as factories</td>
<td>4</td>
</tr>
<tr>
<td>Urban agriculture, but also an idea of urbanism</td>
<td>3</td>
</tr>
<tr>
<td>Mentioning aquaponics</td>
<td>2</td>
</tr>
<tr>
<td>References to democracy or community</td>
<td>2</td>
</tr>
<tr>
<td>Environment (how is this term used? Indoor? Outdoor? Controlled or contingent?)</td>
<td>2</td>
</tr>
<tr>
<td>Appeal of or focus on a certain food or food in general</td>
<td>2</td>
</tr>
<tr>
<td>Mentioning freshness</td>
<td>2</td>
</tr>
<tr>
<td>A futurist way of speaking about VF, or a focus on possibilities rather than facts</td>
<td>2</td>
</tr>
<tr>
<td>References to price or affordability</td>
<td>2</td>
</tr>
<tr>
<td>Referring to VF as a means of (private or individual) self-sufficiency / independence</td>
<td>2</td>
</tr>
<tr>
<td>Focus on stacking or layering in cultivation</td>
<td>2</td>
</tr>
<tr>
<td>“We feed the world” narrative. Anything related to this narrative</td>
<td>2</td>
</tr>
</tbody>
</table>

*Table 7: Code results in comments relating to the concept of VF*
4.7. **Participants’ responses: “How important is technological innovation for the future of food?”**

The answer options for the above-mentioned questions were:

- Very important
- Important
- Neither important, nor unimportant
- Unimportant
- Very unimportant

Almost all (90 percent) participants stated that technological innovation was very important or important for the future of food. The most frequent answer was “very important” with 61 per cent, as the below Figure 11 shows. Only 3 % of participants perceived technological innovation as (very) unimportant.

![Fig. 11: pie chart indicating the importance of technology for the future of food](image)

4.8. **Participants’ responses: “What influences the decisions you make about food? Select up to three from the below options.”**

The answer options for the above-mentioned questions were:

- Nutritional value
- Grown locally
- Price of food item
- Organic production
- Grown outdoors
- Ethical business practices
- Other
The survey was designed in such a way that respondents could choose up to three influences on food decisions out of a selection of seven (one of which was unspecified and open for any comment, named “other”). Decision influences are listed below with the share in percentage of their selection in descending frequency. The significantly most popular influences on food decisions were nutrition on price. By far the least popular influence on food decisions was outdoor cultivation.

Concerning familiarity with vertical farming, the popularity of the influences on food was as follows (in descending order of frequency for each category):

For the 18 individuals reporting they were familiar with vertical farming:

- Price (selected 11 times)
- Locality and nutrition (each selected 9 times)
- Ethical reasons (selected 6 times)
- Organic labelling (selected 3 times)
- Outdoor cultivation (selected once)

For the 37 individuals reporting they were slightly familiar with vertical farming:

- Nutrition (selected 23 times)
- Price (selected 21 times)
- Organic labelling (selected 12 times)
- Ethical reasons (selected 9 times)
- Outdoor cultivation (selected twice)

For the 61 individuals reporting they were not familiar with vertical farming:

- Nutrition (selected 42 times)
- Price (selected 37 times)
- Locality (selected 22 times)
- Ethical reasons (selected 12 times)
- Outdoor cultivation (selected 7 times)

Nutrition

![Fig 12: Percentage of selected most important category nutrition](image)
Price

Fig 13: Percentage of selected most important category price

Local

Fig 14: Percentage of selected most important category locality

Organic

Fig 15: Percentage of selected most important category organic
Ethical reasons

![Ethical reasons chart]

*Fig 16: Percentage of selected most important category ethical reasons*

Outdoors

![Outdoors chart]

*Fig 17: Percentage of selected most important category outdoor cultivation*

Other / miscellaneous influence on food

Six (out of 115) survey respondents specified individual influences on their food decisions that they felt did not belong to the survey’s predetermined influence categories. These influences were:

- **Less plastic packaging** (participant reported slight familiarity with VF)
- **Quality** (participant reported familiarity with VF)
- **Seasonal produce** (participant reported slight familiarity with VF)
- **Taste** (participant reported no familiarity with VF)
- **Vegan food** (mentioned twice) (participants reported familiarity and slight familiarity with VF)
4.9. **Participants’ responses: “Optional: How old are you?”**

The most frequent answer to the survey question about age was no indication of age (27 percent), closely followed by the age range 36 to 45 (26 percent). From the responses that indicated age, the average age is 36.8. The median age (which is not skewed by outliers) is 37.

![Pie chart indicating age](image1.png)

**Fig. 17: pie chart indicating age**


Of the respondents in London that indicated their residence, the great majority indicated Great Britain (41 per cent of all respondents). The most frequent response was no indication of residence (48 percent). Ukraine was the second most frequent indicated residence at two percent. In total, respondents resided in 11 different countries (not including those who did not indicate residence). All residences can be seen in the below Figure 18.

![Pie chart indicating residence](image2.png)

**Fig. 18: pie chart indicating residence**

**Index for Fig. 18:**
- GB: Great Britain
- DE: Germany
- UA: Ukraine
- EU: European Union
- BE: Belgium
- FR: France
- IT: Italy
- NO: Norway
- PH: Philippines
- RO: Romania
- US: United States
4.11. **Individual cases: Connections between comments, images and segmentation variables**

This section analyses connections between comments, images and the segmentation variables age, familiarity, technology, nationality, and influences on decisions about food. The focus is on five individual respondents as cases. The five case individuals were selected due to their noteworthiness in terms of interesting or elaborate comments, the top or bottom end of a spectrum, or other noteworthy features.

**Case 1: Images and comments relating to age**

Individual No. 1, a British resident with the highest indicated age of 78, saw VF as an area of development, implying an orientation towards the future. The selected images featured a crate of harvested food on a conventional field, a countryside with mountains, and a person eating lettuce from a pillar of vertically farmed greens. This individual indicated familiarity with VF, and described technological innovation as very important for the future of food. Individual 1 chose only one influence on food decisions: nutrition.

**Case 2: Images and comments relating to familiarity with VF**

Individual No. 2, a British resident indicating no familiarity at all with VF, reported that technological innovation was neither important, nor unimportant for the future of food. Individual No. 2 indicated locality, nutrition and outdoor cultivation as the most influential criteria on decisions about food. This individual described vertical farming as unnatural because of the lack of sunlight and reported that his/her images were selected because “it fits in with the info we were given”, implying this perception was dictated by the exhibition rather than previous associations. He/she selected images showing pink light, shelves of plant cultivation, and a close-up shot of a lettuce seedling growing in a pillar.

**Case 3: Images and comments relating to attitude towards technology**

Most participants perceived technological innovation as either important or very important for the future of food. Individual No. 3, a British resident, aged 41, described technological innovation as very important and indicated slight familiarity with VF. Chosen influences on food decisions were ethical reasons, nutrition and price. In his/her comments individual No. 3 described VF as “sustainable and ecologically sound”, and described the image selection as “These highlight the scale of what could be achieved”. Chosen images depicted a large amount of lettuce grown in shelves in a green house, a futuristic architectural rendering, and a large amount of tomatoes, implying that increasing food supply was a motive.

**Case 4: Images and comments relating to residence**

Most participants resided in Great Britain, reflected in Individuals 1-3. An exceptional residence was the Philippines. Individual No. 4 reported residence in the Philippines and an age of 45. He/she was not familiar at all with VF and perceived technological innovation as very important for the future of food. His/her influences on food decisions were ethical reasons, nutrition and price. In comments, Individual No. 4 described VF as “farming without soil” and described his/her image selection as “the look out of the ordinary”. Selected images depicted pink light in all cases, a large amount of shelves filled with plants in a factory, a growth chamber with an industrial/confined appeal like a submarine or spaceship, and herbs growing out of a wall section.
Case 5: Images and comments relating to influences on decisions about food

The least important influence indicated on food decisions was outdoor cultivation. Individual No. 5 chose outdoor cultivation and organic labelling as the only relevant influences on food decisions. He/she reported residence in Great Britain, slight familiarity with VF and perceived importance of technological innovation for the future of food. In comments, Individual No. 5 described VF as resource-efficient and his/her image selection as “artificial conditions”, implying a slightly favourable, but nonetheless sceptical stance towards VF.

4.12. Impressions from interactions with London’s museum visitors (field notes)

One main impression concerning the procedure of the event was that the children’s activity (drawing vertical farms on postcards) was very popular. Some children spent up to 20 minutes drawing at the exhibition stand, while their parents waited, often taking the survey. The television screen showing a video of how vertical farming works, was also a popular element of the stand, drawing in much attention. The video also defined more explicitly what vertical farming is, so people’s selected images and themes were likely influenced in that way. This is because the pink light was much more prominent in the London setting due the large TV and the lack of natural light, compared to Munich. Decorative herbs also attracted visitors to the stand on half of the second day and the third day of the event.

Many children did not understand the concept of vertical farming fully. In particular, as we anticipated, the meaning of “vertical” provided challenging for children. Parents and the project team often moved their hands upwards to explain the word while mentioning that vertical means going up. Children were then asked to draw their understanding of farming, while making the upwards hand gesture. One parent remarked that the concept was too advanced for her children. However, many children showed their understanding of VF by drawing images that were quite similar to reality, such as stacked plants, carrots, and buildings. In some cases, adults also drew images on the postcards.

Visitors in London were overall open-minded and curious, but also quite critical. Reactions to VF in conversations with staff are summarized in the following categories: positive, negative and neutral.

Positive reactions in conversations with staff included the following:

<table>
<thead>
<tr>
<th>Interactions: most common positive themes included in interactions are listed below:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reducing pesticides: Satisfaction about the reduction of pesticides through VF</td>
</tr>
<tr>
<td>• Context of dry regions: Hopefulness that VF could be beneficial for dry or drought-stricken areas</td>
</tr>
</tbody>
</table>

Neutral reactions in conversations with staff included the following:
Interactions: most common neutral themes included in interactions are listed below:

- **Curiosity:** A very common reaction was curiosity about where vertical farms are located, and whether vertical farms existed in visitors’ own area of residence.
- **Replacing existing farming systems:** The question whether this technology would replace current farming (however, this remark could also be placed under ‘skeptical reactions’).
- **Plant Variety:** The question which plants could be grown in VF.
- **Nutritional value:** Questions about the nutritional value of vertically farmed products.
- **Verticality along building facades:** Associations of growing plants on the outside of buildings.
- **Inevitability:** Asking sceptical questions at first, indication of being content with eating VF products, as this was seen as inevitable due to food system problems.

Negative reactions in conversations with staff included the following:

Interactions: most common negative themes included in interactions are listed below:

- **Unnaturalness:** The most common sceptical reaction was an aversion to perceived unnaturalness or artificialness of VF. Visitors labelled VF as “fake” and “man made”. One visitor remarked “we are losing contact to nature.” Another noted that although she disliked the artificialness of VF, she felt that she needed to accept it, because unnaturalness was an unavoidable future.
- **Energy use:** One visitor noted “I feel like you are hiding something.” Another visitor noted that he did not know whether the information communicated at the event was true. A feeling of distrust may relate to the display of energy, which on the roll-up banner from PlantLab was demonstrated by colour ranges rather than numbers (due to inconsistency in average numbers). Water usage and productivity were displayed more clearly by average numbers.
- **Price:** The question whether vertically farmed produce would be more expensive than current products.
- **Pollination:** Worry about where bees would get their pollen.
- **Sterility:** The question whether bacteria would spread and whether VF was sterile enough. Counter to that, the question also came up whether VF and the vertically produced food would be too sterile.
- **Full Automation:** Worry that VF is fully automated, followed by relief to “see human hands” in visuals.
- **Taste:** Question about whether vertically farmed food would taste different to current food.
- **Health:** Concern about negative effects on health.
- **GMO connotation:** Associating vertically farmed food with genetically modified food and negative connotation of GMO.
4.13. Conclusion for citizen participation at Science Museum

The overall attitude among visitors at the Science Museum in London towards vertical farming differed according to whether the source was survey responses or conversations in person. In survey responses, the attitude was mainly positive but also noticeably sceptical. In conversation, the attitude was mainly sceptical or neutral, and sometimes positive. Common positive associations with VF were resource-efficiency (including space-efficiency and water-efficiency) and perceived sustainability. Sceptical reactions in survey comments included perceived unnaturalness or artificialness of VF. In conversations with TUM and EUFIC staff members, various negative reactions were noticeable such as a feeling of distrust or unease concerning the often-concealed use of energy. It is noteworthy that participants reacted more sceptical in personal interactions with staff members than in the survey. This could imply that deeper, richer interactions uncover more concerns during such citizen-engagement events. It also shows that surveys alone are perhaps not sufficient to provide an accurate (or sole) set of data from which conclusions can be drawn. Therefore, taking field notes through participant observation throughout the event was as important a source of information.

Respondents in London chose similar, but not identical ways of visualizing vertical farming as images compared to describing vertical farming in words. This similarity is noteworthy given the communication concept at the Science Museum, which explicitly visualized vertical farming as indoor controlled growth settings. In London, vertical farming was associated with space- and resource-efficiency, indoor-cultivation, verticality, artificialness, sustainability and light. Visualizations of VF centred on stacked, edible plants, light, technology, people, gardening, and buildings, including greenhouses. Associations with visuals were described as verticality, indoor-cultivation, light, technology, space-efficiency, aesthetic appeal, large-scale production, and a focus on the future. Parallels in these expressions of associations were operational descriptions such as the vertical cultivation of plants indoors with artificial light. Differences were that a focus on the future was more prominent in associations with visuals than in associations with the definition of VF. Further, participants selected and spoke about images more positively than descriptions of what VF means (e.g. describing VF as artificial, but selecting images with people and describing them as aesthetically appealing). This implies a key finding, which is that visuals help evoke a more favourable attitude towards VF than a theoretical description. Like in Munich, besides commercial representations, VF was also implied to be part of private life, e.g. by being displayed in gardens and as part of residential buildings.

When asked to describe what VF means, participants in London focused on the benefits of VF, particularly sustainability, including a reduction of used acreage as well as resource-efficiency. Comments also often included rather neutral remarks such as verticality, indoors, and lighting. Artificialness (“unnaturalness”) was a noteworthy common sceptical remark in comments.

To conclude impressions from London, the strongest interests of participants could be considered to be the (1) efficiency in terms of space and other resources (2) sustainability and (3) naturalness vs. artificialness.
5. Comparison and conclusion for citizen participation in Munich and London

As mentioned in the above executive summary, there were several differences concerning the overall setting of both events that limited the immediate comparability of the events. One noteworthy difference was the audiences. More elderly visitors were present in Munich compared to London. In London, much more children with middle-aged or young parents were present, given the Family Festival. There was slightly more public engagement in London, both in terms of conversations and collected survey responses. This was likely due to the fact that the event in London took part during the holidays. Another socioeconomic difference is that museums in London are generally free of charge, while museums in Munich, like the Deutsches Museum, are not.

A further difference between events was that in London, participants were chatty and open to talk, most likely due to gratitude that their children were being entertained as a form of free service or subliminal quid pro quo arrangement. Visitors in Munich were more reserved. The event at the Deutsches Museum was also not well advertised within the museum on the days of the event (as one museum staff member had informed us). The event in London was advertised to a greater extent than the event in Munich, since the London event was tied into the program of a family festival. Further, there was a language barrier in Munich, as many project partners did not speak German fluently to interact with German-only speaking visitors. This can be a reason for why participants in London were perceived to be chattier. Overall, in the UK public engagement in museums has a longer tradition than in German museums, which indicates a higher likelihood of being more reserved in public in case of the latter. Another difference was that in London a TV monitor showed a video displaying pink light in indoor controlled settings (further, the setting in the basement gallery did not provide daylight, compared to the brighter Ehrensaal at the Deutsches Museum).

Keeping in mind the differences and limited comparability of the events, the following shows a comparison of the responses.

As a result of the priming effect of pink light on the television in London, a hypothesis was that the collected visions in London would include more high-tech images and indoor controlled settings. However, this hypothesis was falsified, as pink light was mentioned relatively infrequently. Instead, there was more focus on a lack of sunlight than the existence of artificial light. This focus on lacking sunlight was much more present in London than in Munich. Generally, colours (e.g. green plants, pink light) were not as popular in comments in London as in Munich. The colour green and pink light were mentioned significantly more often in Munich than in London.

There was a higher reported familiarity with VF in Munich compared to London (79 % vs. 51 %). Similarities in selected images (as visualized associations with VF) in Munich and London were the same high frequency of stacked, edible plants, pink light, people, technology, gardening, and buildings. Differences in selected images were: more associations with food in Munich, and more associations with white light and greenhouses in London.
When describing their images, participants in Munich and London both frequently mentioned verticality, technology, future, and efficiency. A difference was that in Munich, the themes green colour and food were mentioned much more often than in London. In London, light (artificial light, lack of sunlight) was a much more popular topic than in Munich. Large-scale food production and aesthetic appeal were also more frequently mentioned in London compared to Munich.

When describing the meaning of VF, similarities in Munich and London were the same high frequency of the themes verticality, efficiency and sustainability. Differences were firstly, the higher popularity of future, appeal of novelty, urbanism and food in Munich compared to London. In London, there was more focus on indoor cultivation, artificialness / unnaturalness and lighting.

Technological innovation was popular with participants in Munich and London. In both locations, most participants reported that technological innovation was important or very important (83 % in Munich and 90 % in London)

Concerning influences on food decisions, ethical reasons and outdoor cultivation were similarly least important in Munich and London. Locality and organic labelling were more important in Munich than in London, whereas nutrition was more important in London than in Munich.

Both in Munich and London, most participants did not want to disclose their age. Of the respondents that did indicate age, the average age was 35 in Munich and 37 in London.

Both in Munich and London, many participants did not indicate residence. Amongst the respondents that did indicate residence, the most frequent answer in Munich was Germany (42 %), and in London it was Great Britain (41 %).

In conversations with event staff, participants in Munich reacted slightly more favourably towards VF than in London. Visitors in Munich and London both praised the potential to reduce pesticide use and increase food security. Visitors in both locations criticized high-energy use, perceived associations with GMO, exaggerated importance of technology, and unnaturalness (in Munich lamented as lack of soil, in London lamented as lack of sunlight).

How humans live or should live together, in terms of ideas of urbanism and future, was a more popular focus in Munich than in London. Overall, comments about the meaning of VF were more positive and even idealistic in Munich compared to London. A particularly significant difference was higher scepticism towards unnaturalness or artificialness in London compared to Munich.

To conclude, the perception of participants is meaningful for the project “Cultivating Engagement: a Citizen Participation Forum on Vertical Farming” because it reflects a form of citizen participation where citizens are invited to create and share their own understanding – their related issues – of a novel practice. Following the methodological approach of issue mapping, data was collected in a setup that allowed associations between vertical farming and wider issues. One suggestion in that regard is to have different stakeholders presenting on a novel technology, such as social scientists from a university, business representatives and actors from the political sphere, to display their material and perspectives as explicitly different positions. Overall, citizens were curious about VF in London and Munich and in both locations praised efficiency in terms of space and resources, hopes for food security, a positive attitude towards the use of technology, and optimism for the future.
The Social Media Survey was not only used during the two events in Munich and London, but also to a lesser extent via web distribution and as an activity during a so-called “Tag der offenen Tür” (open house day) event at the Technical University Munich. In the following, a brief summary of the results from these two sources is given.

6.1. Web results

The survey was distributed via online channels administered by EUFIC (see DEL 02), in public presentations by Mascha Gugganig, and convenience sampling through the Munich Center for Technology in Society. Seventeen individuals participated in the Social Media Survey via web invitation between July and October 2018. The average age of respondents was 33. The lowest age was 23, and the highest age was 63. Concerning survey language, six participants chose German, and eleven chose English. Seven participants reported Germany as their residence, two France, one Spain, one Canada, one Denmark, and one Switzerland. One participant reported no familiarity with VF, seven reported they were somewhat familiar with VF, and nine reported they were familiar with VF.

Familiarity and technology were not correlated (there was no connection between someone’s familiarity with VF and how important they perceived technology and innovation to be). Participants were, on average, slightly in favour of technology and innovation. Three participants described technology and innovation as unimportant. One participant reported technology and innovation as very unimportant. Six participants described technology and innovation as important, and six as very important.

Concerning influences on food decisions, in descending order of popularity, they were: price, local origin and nutritional value (both with nine votes), organic labelling, and ethical considerations. By far the least important factor was outdoor cultivation with zero votes. Some participants mentioned other influences: convenience, familiarity, taste, habits of the social circle, aesthetic appeal, freshness, and appetite.

Comments and titles describing selected images included the following themes of associations: novelty, education and empowerment, laboratories, growth, medium and large-scale production, people, infrastructure, urbanism, indoors, food, building on tradition of historic forms of VF, gardens, sustainability, technology-intensiveness, and efficiency.

The 51 selected images showed the themes visible in the below table, in descending frequency. The most popular themes were edible plants, stacked plants, technology, people, white light, pink light, buildings, and gardens.
<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants (sum of all types of plants)</td>
<td>71</td>
</tr>
<tr>
<td>Plants: edible</td>
<td>33</td>
</tr>
<tr>
<td>Plants: Stacks or layers of plants (shelves / pillars / pipes / tubes / pyramids)</td>
<td>32</td>
</tr>
<tr>
<td>Technology</td>
<td>22</td>
</tr>
<tr>
<td>People (sum of all types of people)</td>
<td>18</td>
</tr>
<tr>
<td>Light: Yellow or white light</td>
<td>17</td>
</tr>
<tr>
<td>Light: Pink / purple light</td>
<td>15</td>
</tr>
<tr>
<td>People: farm worker / employee</td>
<td>11</td>
</tr>
<tr>
<td>Buildings (sum of all types of buildings)</td>
<td>10</td>
</tr>
<tr>
<td>Garden (or in some cases balcony or terrace)</td>
<td>8</td>
</tr>
<tr>
<td>People: private person</td>
<td>5</td>
</tr>
<tr>
<td>Plants: decorative</td>
<td>5</td>
</tr>
<tr>
<td>Empty shelves or empty plant pillars</td>
<td>4</td>
</tr>
<tr>
<td>Plants: unclear / indistinguishable</td>
<td>4</td>
</tr>
<tr>
<td>Building: futuristic sketch</td>
<td>3</td>
</tr>
<tr>
<td>Buildings: Residential (mostly tall) - plants on exterior</td>
<td>3</td>
</tr>
<tr>
<td>Greenhouse</td>
<td>3</td>
</tr>
<tr>
<td>Pamphlets / brochures / advertisements from VF businesses</td>
<td>3</td>
</tr>
<tr>
<td>Buildings: Residential (mostly tall) - plants as part of interior</td>
<td>2</td>
</tr>
<tr>
<td>Factory building, no plants</td>
<td>2</td>
</tr>
<tr>
<td>People: unclear / indistinguishable (e.g. only hands visible)</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 5: Frequency of selected themes in web results

6.2. Tag der offenen Tür (Open House)

The Open House day of the Technical University Munich took place on the campus of Technical University in Munich on October 13, 2018. Most visitors were students or pupils, sometimes accompanied by parents or grandparents. In conversations with staff, many visitors mentioned that they knew VF to some degree, and could associate vertical and controlled plant cultivation with the topic. An Indian student mentioned vertical strawberry fields, which he remarked were common in India.

Sixteen visitors participated in the Social Media Survey on the open house day. The average age of respondents was 23. The lowest age was 16, and the highest age was 42. Concerning survey language, nine participants chose German, and seven chose English. Twelve participants reported Germany as their residence, two India, one Austria, and one Canada.

Most participants had little or no knowledge of VF: Six participants reported no familiarity with VF, seven reported they were somewhat familiar with VF, and three reported they were familiar with VF. Concerning the importance of technology and innovation for the future of food, participants were in favour of technology and innovation. Zero participants described technology and innovation as unimportant. Nine participants described technology and innovation as important, and seven as very important. This is not surprising, given that the event was the Open House for a technical university.

Concerning influences on food decisions, in descending order of frequency, they were: local origin, organic labelling, nutritional value, ethical considerations and price (both chosen the same amount of times) and, again, by far the least important factor, outdoor cultivation (with only one vote).

Comments and titles describing selected images included the following remarks: the reduction of used acreage, the increase of production, future production of food, appealing aesthetics, realistic presentation, using buildings to grow plants and increase oxygen production, growing on the outside of
buildings along walls, food security, efficiency and novelty, good flavour and convenience, and artificial growth.

The 48 selected images showed the themes visible in the below table, in descending frequency. The most popular themes were stacked plants, edible plants, people, white light, technology, and buildings, indistinguishable plants, and greenhouses.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants (sum of all types of plants)</td>
<td>66</td>
</tr>
<tr>
<td>Plants: Stacks or layers of plants (shelves / pillars / pipes / tubes / pyramids)</td>
<td>30</td>
</tr>
<tr>
<td>Plants: edible</td>
<td>23</td>
</tr>
<tr>
<td>People (sum of all types of people)</td>
<td>15</td>
</tr>
<tr>
<td>Light: Yellow or white light</td>
<td>12</td>
</tr>
<tr>
<td>Technology</td>
<td>11</td>
</tr>
<tr>
<td>Buildings (sum of all types of buildings)</td>
<td>11</td>
</tr>
<tr>
<td>Plants: unclear / indistinguishable</td>
<td>10</td>
</tr>
<tr>
<td>Greenhouse</td>
<td>7</td>
</tr>
<tr>
<td>People: farm worker / employee</td>
<td>7</td>
</tr>
<tr>
<td>Garden (or in some cases balcony or terrace)</td>
<td>6</td>
</tr>
<tr>
<td>Light: Pink / purple light</td>
<td>6</td>
</tr>
<tr>
<td>Buildings: Residential (mostly tall) – plants on exterior</td>
<td>5</td>
</tr>
<tr>
<td>People: private person</td>
<td>5</td>
</tr>
<tr>
<td>Building: futuristic sketch</td>
<td>3</td>
</tr>
<tr>
<td>Empty shelves or empty plant pillars</td>
<td>3</td>
</tr>
<tr>
<td>People: unclear / indistinguishable (e.g. only hands visible)</td>
<td>3</td>
</tr>
<tr>
<td>Plants: decorative</td>
<td>3</td>
</tr>
<tr>
<td>Buildings: Residential (mostly tall) – plants as part of interior</td>
<td>2</td>
</tr>
</tbody>
</table>

*Table 6: Frequency of selected themes in open house day results*