

Article

How Young Consumers Perceive Vertical Farming in the Nordics. Is the Market Ready for the Coming Boom?

Linthujan Perambalam ¹, Dafni D. Avgoustaki ^{1,2} , Aspasia Efthimiadou ³ , Yongming Liu ⁴, Ying Wang ⁴, Maozhi Ren ^{4,5}, Antonios Petridis ⁶ and George Xydis ^{1,*} 

¹ Department of Business Development and Technology, Aarhus University, Birk Centerpark 15, 7400 Herning, Denmark; 201607826@post.au.dk (L.P.); dafni_av@btech.au.dk (D.D.A.)

² Department of Natural Resources and Agricultural Engineering, Agricultural University of Athens, Iera Odos 75, 11855 Athens, Greece

³ Department of Soil Science of Athens, Institute of Soil and Water Resources, Hellenic Agricultural Organization-Demeter, Sofokli Venizelou 1, Lycovrissi, 14123 Attica, Greece; sissyefthimiadou@gmail.com

⁴ Institute of Urban Agriculture, Chinese Academy of Agricultural Sciences, Chengdu 610000, China; liuyongming01@caas.cn (Y.L.); wangying0013@126.com (Y.W.); renmaozhi01@caas.cn (M.R.)

⁵ Zhengzhou Research Base, State Key Laboratory of Cotton Biology, Zhengzhou University, Zhengzhou 450000, China

⁶ Department of Food Science, Aarhus University, Agro Food Park 48, 8200 Aarhus, Denmark; apetridis@food.au.dk

* Correspondence: gxydis@btech.au.dk; Tel.: 004593508006



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Abstract: Producing food via vertical farming (VF) is an efficient method since it requires less space with increased yield per unit area. Such a system can assist in solving major food-shortage problems since it presents a higher crop yield per unit area compared to conventional farming. Thus, VF can be seen as a production method that can cope with the challenge of the constantly growing population, making it also possible to cultivate crops in regions with adverse climate conditions. However, the public might be concerned about the sustainability of VF systems since plants are produced in an unconventional setting. Therefore, there is a need to consider and evaluate the consumers' acceptance of VF. The particular study attempts to both analyse consumer acceptance of VF in the Nordic areas and offer insights into VF acceptance among young customers in a comparative analysis. The results indicated that VF is not widely accepted by young Nordic consumers. The concept of sustainability is one of the principles driving forces behind consumer acceptance of vertical farms. The more cases of vertical farms in European cities, the better seems to be the level of acceptance among young customers and their willingness to purchase their products.

Keywords: vertical farming; consumer acceptance; crops; yield

1. Introduction

The world population is growing, which makes it difficult to ensure access to sustainable food for all [1]. The democratisation of food production and demand for the citizens to be able to participate and consume has been emphasised in several fora [2]. The global population at 8.5 billion by 2030 and almost 10 billion by 2050 would equal fewer resources that can be naturally harvested [3]. Studies have shown that cultivation in agricultural land where water is a scarce source is rather low [4]. It is estimated that by the year 2050, we will need to produce 60% more food than what is produced nowadays. Therefore, the need to introduce more efficient and effective solutions to secure these resources is imperative [5]. One of these solutions can be Vertical Farming (VF). VF is considered a modern form of agriculture, where the essential resources (such as water, energy, nutrients) and time needed to produce crops are significantly fewer than in conventional farming. On a VF system, the growing conditions are fully controllable, which eliminates the negative impact of climate change or adverse climate conditions and enhances productivity [6]. Inside

VFs, food grows in soilless cultivating methods (such as hydroponics and aeroponics) on multiple racks vertically stacked, maximising in this way the yield production per m². Furthermore, solar radiation is fully replaced by advanced artificial lighting solutions that provide lighting in the optimum quality, quantity and duration of the light spectrum in order to improve the production volume and quality characteristics of the crops [7].

The innovation in the field of VF is increasing, and new applications are constantly coming out to further optimise the production and at the same time reduce the operational and capital expenses of the farms. There are companies producing various products via VF, such as micro-algae [8] or even staple food crops [9], which would be considered unthinkable a few years back. This makes indoor VFs flexible, efficient and smarter and simultaneously enhances crops' yield. There are also companies and researchers that focus on optimising the operation of VF systems correlating the needs of the plants and the needs of farms. These include optimisation of indoor air quality (such as RH%, CO₂), substrates and their properties, nutrients, lighting and heating indoor solutions, such as the Time of Use (ToU) options, and load shifting based on energy pricing forecast opportunities [10]. It should also be mentioned that artificial light, in addition to being a key element in the growth of indoor crops, highly affects the energy consumption of vertical farms. As stated by Avgoustaki, 2019 [7], electricity cost is one of the most significant expenses in VFs, consisting almost 40% of the total production cost, while approximately 80% of the electricity demand covers the multiple hourly lighting operation (and the remaining electricity goes to motors, pumps and other machinery). Energy consumption could be used as an indicator of VFs' sustainability level. Furthermore, it is important to mention that VFs could significantly contribute to the reduction of the CO₂ emissions related to food transportation (food miles) and production. Since VFs are mainly located in the urban and peri-urban environment and at the same time the high level of airtightness level (around 0.87–0.89) [11], they emit 40–75% less carbon compared to open-field farms and greenhouses [12].

VF is gaining increasing popularity among the world's biggest urban centres, although the method is still not very widespread in Denmark. In Denmark, consumers are not properly informed about the method of VF and they seem to mainly gravitate towards conventional farming due to the long history of traditional agriculture in the country [5]. Therefore, it would be interesting to analyse the extent of consumer acceptance of VF in Denmark as well as in comparison with other countries, such as Germany, where it is already known that the highest levels of social acceptance are met in urban agriculture [13–15]. Another study conducted by [16] Ambroise (2019) discusses how VFs could benefit a wealthy and densely populated city, such as Paris, France, which targets a green transition by 2050. This is discussed by explaining that informing consumers, promoting VF and explaining this novel method to them could offer production of locally grown premium vegetables to a city with high-priced food. However, he underlines that consumers are still not familiar with distinguishing organic from vertical farming products while the price is still a vital argument against buying such products. There is a lot of explorative research to be conducted on customer acceptance of VF, as results of another study on the same topic showed that customers perceive vertically farmed lettuce as less natural, and they seem less willing to buy it compared to foods from other production systems [17].

Additionally, the majority of the consumers are not concerned about the environmental impact, the food miles and the produced method of their food [18,19]. Vertical farming helps establish a more direct relationship between the producer and consumers based on professional communication regarding the characteristics and the quality of the products. This way, consumers enrich their awareness and knowledge while reducing the number of entities as a short supply chain model. Under this direction, consumers would be more knowledgeable of what they consume and how the dietary preferences affect both their well-being and their ecological footprint. Another study examined the levels of acceptance among urban residents, underlining that a combination of commercial, social and ecological

factors is more likely to increase their acceptability and help VF successfully penetrate into the market.

According to Solomon [20], a way to learn and evaluate the customers' thinking process when met with a VF product is to observe the way they act in front of the product. Specifically, that includes first impression, exposure through the environment and most importantly, their interpretation of all that. Additionally, significant external factors like culture, family and lifestyle can highly influence customers' choices.

Research on customer acceptance of vertical farming products is still lacking, especially in countries, such as Denmark, which is considered among the biggest financial forces in Europe with an expansive organic food market [21]. The goal of this research is to investigate the main driving forces for the acceptance of vertical farming systems and VF products and the behavioural intention of consumers towards buying the products. Thus, the subject of this study is of vital importance since vertical farms are considered a means for feeding the growing population in urban areas while producing food in a more sustainable way in regions that are heavily impacted by climate conditions. Furthermore, due to the fact that vertical farms are still a new technology, there is still a lot of distrust towards their products. Consecutively, this disbelief can jeopardise the profitability of the farms and increase the risk of bankruptcy. Furthermore, it would be helpful to promote the VF to consumers while also creating a database for potential advice on future vertical farms.

Globally, numerous innovative approaches try to produce food in the urban environment by applying identical or complementary growing methods. The identification of the obstacles of the vertical farming approach among consumers could create the necessary basis for stakeholders, investors and farmers to overcome the existing barriers and develop a successful business model for local food production. Identifying and introducing innovative food production methods to the consumers—such as vertical farming—is of vital importance towards public acceptance. Recent agricultural technological innovations, such as genetically modified (GM) crops, artificial radiation or even nanotechnology, have been often treated with scepticism and distrust; therefore, the consumers' overall perception of vertical farming and their products is still blurry. This study aims to raise awareness of the needs for such systems via a holistic approach, such as in the study of Xydis et al. [21], and enlighten the existing gaps between the stakeholder and consumers. At this point, the question to be addressed is, "To what extent do consumers accept VF products in Denmark?".

2. Methods

2.1. Data Generation

In order to answer the former research question, it is essential to follow a methodology primarily consisting of both quantitative and qualitative data on VF. The research did not initially intend to focus solely on Denmark. The qualitative data were acquired via a questionnaire filled in by participants in three Scandinavian countries: Denmark, Sweden, and Norway. Responses with many missing entries or with answers in a certain pattern were removed. Since the number of respondents from countries outside of Denmark was limited, the focus of the research narrowed down to Denmark alone, while responses from Sweden and Norway were removed since they could risk the validity and credibility of the research. Thus, in the end, samples of 111 Danish respondents were used for a detailed data analysis. The questionnaire consisted of a basic demographic profile of the participants. It involved quota parameters such as gender, age, education and income, mainly representing younger people and students. The experimental data collection of the sample conducted in the university environment allows the research to have access to young consumers in the age group between 21 and 30, who are deemed to be the future consumers and are capable of making a difference in the next decades [22]. Next, there were some questions regarding the existing knowledge and attitudes towards vertical farming. The statements were evaluated on a scale of choices from "yes" and "maybe" to "no".

The statements regarding vertical farming were used to build the Technology Acceptance Model (TAM) constructs, and all the questions were randomised so that the order in which the statements were arranged would not affect the results [23,24]. Additionally, statements about perceived sustainability were answered and assessed on a five-point scale semantic differential. TAM is based on the theory of reasoned action [25]. Based on Davis [23] and Davis et al. [24], in order to critically determine customer acceptance of pioneering technologies, it is highly important to perceive the usefulness and ease of use that measure the attitude toward implementation of technology. These factors, in turn, assess the behavioural intention to use the new method to use alongside its perceived usefulness. Additionally, the implementation of the system itself provides additional data on the behavioural intention to use the system.

To evaluate the acceptance of vertical farming products in Denmark, an extended acceptance model, which, apart from TAM, is also based on the theory of planned behaviour, was used in the research. A qualitative focus group was set-up in order to enhance the validity of the findings and used a generic qualitative design applying thematic analysis to analyse the data. The goal was to understand some of the underlying reasoning not possibly identified via the questionnaires. The focus group took place via zoom due to COVID-19 restrictions. The focus group intended to explore attitudes towards vertical farming and their products and the use of thematic analysis (TA) was conducted to identify and analyse the meaning of the datasets that were collected [26]. Inductive thematic analysis was carried out as described by Boyatzis (1988) [27] using NVivo software [28]. TA facilitates obtaining knowledge sourcing from the meanings made from the studied phenomenon and provides the necessary framework in order to establish a valid model for consumers' thinking, feeling and behaviour. The data from the focus group were coded and categorised to allow findings' triangulation. To ensure the reliability of the method and the transparency of the coding frame, two independent researchers of this study calculated the correspondence between the applications of the codes to the data.

2.2. Data Handling

The collected data were analysed using the IBM SPSS software package in order to identify and evaluate the patterns obtained from the structural equation modelling. It was constructed in order to allow an explorative evaluation of the data. Meanwhile, seven constructs with reflective indicators were put together. In addition, a strong correlation was expected to occur from the evaluation of these constructs. To obtain a more reliable and precise representation of the collected data, the value of the loadings had to be over 0.40 on the theoretical research model built. Therefore, a few constructs were eliminated because they presented loadings below 0.40, while those above this value were kept. The indicator loadings consisted of composite responsibility and average variance extracted, and the criteria were selected to verify the convergence validity of the model. To thoroughly analyse this, the Average Variance Extracted (AVE) value had to be above 0.5 according to Fornell–Larcker criterion, while the Composite Reliability (CR) value was above 0.7. This would serve as an acceptable indicator/statement that the collected data are internally consistent as well.

3. Theoretical Background

3.1. Vertical Farming

VF is a trending phenomenon within urban farming, gaining growing interest all over the world [29]. In short, vertical farming is the practice of producing food on vertically inclined surfaces stacked in multiple layers instead of farming on a single level only. This way, a solution that requires no external assistance is adopted and can fully operate in a controlled indoor environment [30,31]. Vertical farming uses the three most widely applied systems, all of which can grow food. Firstly, vertical home farms, which are smaller units for household consumption that can be controlled by apps. Subsequently, there are the in-store vertical farms, which are found in grocery stores, where consumers can both look

at the products and make a direct in-store purchase. The indoor vertical farms are larger farms the consumer usually does not have access to, while consumer interaction is only available when they are met with the packaged product [32].

Furthermore, inside VF, all kinds of crops could theoretically grow; however, in a more financial and meaningful way, there is a limited list of selected cultivars suitable for indoor climate-controlled farms, mainly crops that are small in height, planted in high densities and have a small growth cycle [33]. It should be noted that in this study, the term vertical farming is not differentiated and is only used in a broad sense to understand consumer acceptance of VF in general.

In vertical farming, there are mainly two different agriculture techniques that are commonly used: hydroponics and aeroponics, which utilise nutrient-rich water instead of soil for plant nourishment. Thus, VF does not require fertile land in order to be effective, while it uses less water and occupies space compared to the conventional agricultural systems. Furthermore, it is possible to achieve an all-year-long production cycle in VF unaffected by external severe weather conditions since the whole process is in a protected close loop with complete environmental control [34,35].

Hydroponics is the predominant growing system used in vertical farms. In hydroponics, the plant roots are submerged in the nutrient solution, which is regularly monitored and circulated to ensure the maintenance of a correct chemical composition [36].

Aeroponics is still a novelty in the vertical farming world, and it is essentially the method of growing plants in an air/mist environment without any soil and very little water. Growing plants in this system have also shown to be the most efficient plant-growing system for vertical farms, using up to 90% less water than even the most efficient hydroponic systems. Moreover, aeroponics enables the uptake and absorption of more minerals and vitamins, ensuring healthier and nutrient-rich plants [37,38].

Furthermore, the VFs consist of different kinds of technologies that enable immediate and precise traceability and total control of the process. The farm chambers typically consist of thermally controlled growing areas, ventilations fans and irrigation pumps, CO₂ filters, artificial LED lighting, automation robots and different kinds of sensors [38,39]. In order to even close the loops regarding high energy demand, many farms are shifting towards renewable energy sources or other energy management techniques in order to ensure sustainability in the vertical farm [40].

3.2. Benefits and Challenges

Similar to conventional farming, this method of farming also has a few benefits and drawbacks. One of the benefits is the high yield compared to traditional farming. With the global population constantly growing, feeding the whole world is one of the biggest challenges, which can be addressed through VF. Similarly, there is a controlled environment in vertical farming that allows cultivation and harvesting all year round without any influence of climate change [9]. In addition, traditional farming activities like ploughing and seeding require huge amounts of fuel, which is not necessary in the case of VF. Another important advantage of VF is the fact that there is no production of environmental waste and agricultural runoff since the system is closed-loop and easier to manage [6,41]. The recycling aspects also result in 70–95% less water usage [42]. Lastly, vertical farms also eliminate transportations costs and minimise CO₂ emissions because of local production opportunities close to the local consumers and to the major urban areas [43]. Additionally, there are many benefits, such as new high-wage agricultural jobs in cities, fresh food supplies, reduced transportation costs and CO₂ emissions in cities, and it makes it possible to use abandoned warehouses in urban environments [44].

Alongside all the advantages, there are various drawbacks to VF as well. One of the disadvantages is the high start-up costs and the complexity of setting up a VF. Additionally, there are significant operational costs related to high-energy demand, high labour costs, and considerable operation and maintenance costs. In addition, the management of CO₂ emitted is a challenge since, in such systems, CO₂ is produced in a densely stacked farm [45].

Similarly, certain conditions must be followed before planting such systems. One of the most critical factors for assessing the benefits of vertical farming is the comparison of nutrients in products from hydroponic and soil-based environments. Even though there is a wide range of studies that provide evidence in favour of both growing systems, further research is needed depending on the conditions [46].

Regarding consumer behaviour, different researchers have shown that consumers made an extra effort to obtain locally produced food because of its assumed freshness [47,48]. More importantly, peoples' choices on food are also impacted by the use of pesticides, safety, and other factors related to production. Moreover, people also consider environmental issues and ethics. Lately, the importance of urban agriculture and local production has been stressed considering the increasing urban population [49]. However, in the case of vertical farming, there is a lack of awareness among consumers even though it has been around for some time. Furthermore, the concept of artificialness in the farming process remains unclear for consumers, which results in generally being sceptical and perceiving VF as "Frankenfoods" [50]. Even though people encourage rooftop gardening, they are hesitant about the concept of vertical farms. The literature confirms this tendency showing that people still consider the food grown in vertical farms less natural in comparison with traditional and other farming techniques [50]. Nonetheless, some researchers have also shown that there are divided opinions on vertical farming, with some countries, such as China and Germany, having a positive attitude towards food from vertical farms [51].

Therefore, according to information provided by the existing literature, there is a lack of research on consumer acceptance of vertical farming in the Danish market. There are not even enough data—despite the potentials of the market—for the whole of Europe. Butturini and Marcelis [52] published a work on the prospects of VF in Europe, while Specht et al. [9] published a study analysing the acceptability of various new approaches, including vertical farming, among others. In general, there is very little research material regarding vertical farming in Denmark and consumer acceptance. Therefore, this study aims to cover this research gap.

3.3. Theoretical Model

In order to evaluate consumer acceptance, a combination of models is used based on the technology acceptance model (TAM) [23] and the theory of planned behaviour [53]. This was inspired by the work of Jürkenbeck et al. [49], where the researchers combined the two models and adopted an in-depth mathematical approach of evaluation. This study, however, consists of the most fundamental elements in customer acceptance research, while only the most relevant aspects from the framework were selected for this particular context. TAM, in short, describes the fundamental determinants of consumer acceptance regarding technological innovation and how consumer attitude is perceived, which leads to behavioural intentions [23].

The TAM model is a useful tool to measure the acceptance of information technologies via validated decision factors, which are specifically correlated to information technology and widely applied to evaluate usage and acceptance.

In this research, the theory of planned behaviour was also used to predict the behaviour based on the attitude of customers towards the subjective norm [53]. This theory originated in social psychology and is designed to assess human behaviour. Even if the theory of reasoned actions was developed for the purposes of other fields, multiple studies that focus on agricultural and food topics use this model under extended or altered versions in order to fit the research scope and contribute to behavioural analysis [54].

Thus, this leads to the development of a model that can be used to measure consumer acceptance of vertical farming. The final model shifts the focus to sustainability and vertical farming; hence, sustainability is added to the components of the model whenever needed. In short, the four elements on the left help interpret the attitude towards buying vertically farmed products. Consecutively, they offer a better understanding of the behavioural intention to buy. In addition, by comprehending the perceived behavioural control, it

is easier to detect what is possibly lacking [23]. Moreover, the subjective knowledge of consumers may influence the perceived knowledge. By measuring the above-presented variables (attitude toward sustainability, perceived sustainability, subjective knowledge and subjective norm), the perceived usefulness is connected with the attitude towards buying, which consequently generates the behavioural intention to buy. All the relationships of the examined model are presented in Figure 1.

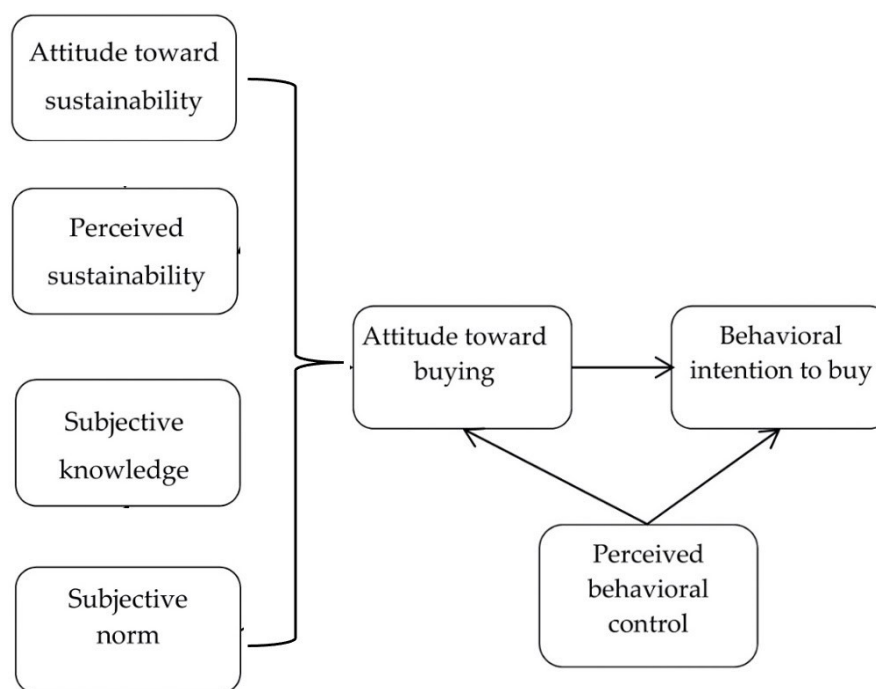


Figure 1. The theory of reasoned action.

4. Results

The research was implemented by using a sample of 111 consumers from Denmark. The percentage distribution of the different socio-demographic profiles concerning gender, age, education, income and population of the sample size community can be seen in Figure 2.

The empirical analysis of the research is presented in Table 1, where it is evident that the majority of the consumers, i.e., 79% are willing to pay more for environmentally friendly products, whereas 20% think otherwise. Up to 51% of the people said that they were familiar with vertical farming, while 48% said they had never heard of the term. Meanwhile, the majority of the consumers, i.e., 86.4%, had never bought any product grown via vertical farming themselves, while 13.5% confirmed they had. Nonetheless, the majority of the consumers (73.8%) showed trust in vertical farms since they responded they would buy from those stores, although 16.2% thought they could not trust these stores.

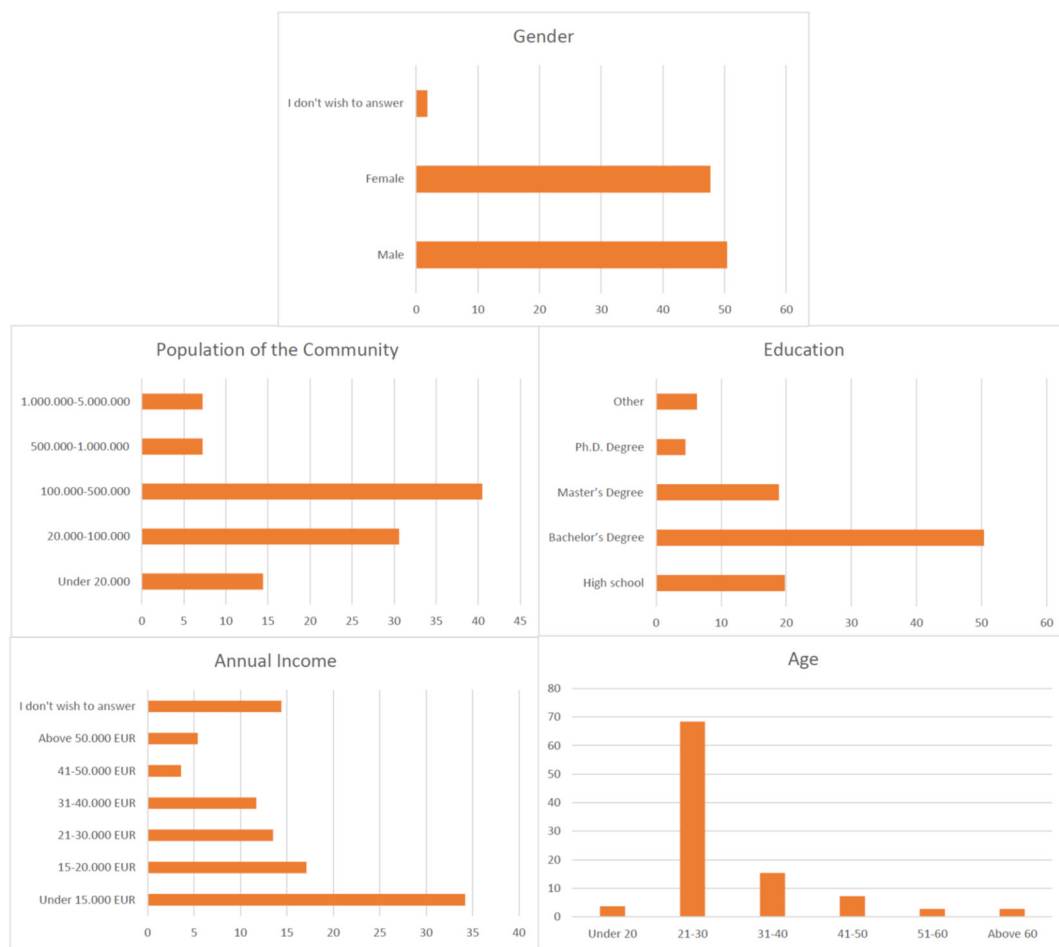


Figure 2. Visual summary of the demographic characteristics of the participants in this study.

Table 1. Consumer/Public responses concerning the general attitude around VF.

Statements	Yes (in %)	Maybe (in %)	No (in %)
Is sustainability important for you?	71.6	0	28.4
Are you aware of indoor vertical farming?	51.3	0	48.6
Have you bought any indoor vertical farms products when available?	13.5	0	86.4
Would you trust buying a product from indoor vertical farms?	73.8	0	16.2
Have you ever seen products from indoor vertical farms while shopping?	16.2	0	79.2
Do you believe that the prices of products from indoor vertical farms are reasonable?	41.4	21.6	36.9
Would your social circle approve of you purchasing vertically farmed goods?	68.4	7.2	32.6
Would you pay a little more for a product that is environmentally friendly?	79.2	0	20.7
Do you believe that indoor vertical farms are the future of agriculture?	18.9	13.5	66.7

Furthermore, 79.2% of the consumers had never seen vertical farms or products from those farms while shopping, and only 16.2% had seen such farms. Furthermore, 41.4% of the people believed that the prices of the products are reasonable, while 21.6% replied maybe and 36.9% thought that the prices are not reasonable. Additionally, 76.6% of the people had not seen examples of these farms in their region either, while only 7.2% had seen such farms in their area. The majority of the people (66.7%) think that vertical farms are not the future of agriculture, while only 18.9% think that it is. Consumers also showed

hesitation towards buying stock shares for indoor farm companies on the stock market. Specifically, 20.7% showed a willingness to buy stocks, and 31.5% refused to buy them, while 47.7% did not properly elaborate on their choice. The results are presented in Table 2.

Table 2. Validity of the constructs of the extended technology acceptance model (where M is the mean value, and SD is the standard deviation).

Constructs	Indicators/Statements	M/SD	CR	AVE
Attitude towards sustainability	Is sustainability important for you?	1.58/0.59	0.879	0.672
Subjective Knowledge	Are you aware of indoor vertical farming?	1.89/0.34	0.635	0.624
Subjective norm	Would your social circle approve of you purchasing vertical farmed goods?	2.98/0.89	0.945	0.745
Perceived sustainability	Do you believe that indoor vertical farms can be the future of agriculture?	2.57/0.36	0.967	0.764
Attitude towards buying	Would you pay a little more for a product that is environmentally friendly?	1.45/0.78	0.76	0.654
Perceived behavioural control	Have you bought any indoor vertical farms products when available?	2.78/0.67	0.785	0.743
Behavioural intention to buy	Would you trust buying a product from indoor vertical farms?	1.67/0.78	0.867	0.743

The results the constructs showed for the model proved that the constructs were valid, and Table 2 shows the detailed results of the average variance extracted and composite reliability. Then, a significant pattern if the construct was detected, showing that perceived sustainability had CR = 0.967, whereas, after that, the subjective norm changed to a CR of 0.945.

If the respondents had a possibility of buying a VF product, 13.5% indicated that they would be willing to make a purchase. Meanwhile, 79% of the respondents said that they are not able to identify in their grocery stores any vertical farming products, whereas 41.4% have an understanding of the increased process of the greeneries. The results are presented in Table 1.

The results of perceived sustainability generally reveal a relatively positive outcome. Overall, it is observed that young consumers do perceive that vertical farms can contribute to local food production. The semantic differentials (perceived sustainability) indicate that vertical farms are perceived as a useful method for a greener food production system, while the system is still not considered environmentally friendly. The results of ANOVA analysis generally imply that young Nordic consumers judge vertical farms to be a trendsetting phenomenon with questionable perspectives for future agriculture. Looking at the results on the consumers' preferences and willingness-to-pay values, it becomes clear that they are still sceptical towards the method though it is difficult to infer their actual behaviour. Nevertheless, the results indicated purchase intentions which are very close to antecedents of purchase behaviour. Willingness-to-pay could be confusing and misleading because consumers often state that they would pay higher prices for a specific product than they actually do in real purchase situations. However, it can be clearly observed that young consumers have a trend of appreciation of locally produced products compared to non-local or imported or other alternative products implying preference and willingness to pay. Although the interest of young consumers in local production is quite high, the proportion of their attitude to buying the products is relatively low. Finally, worth mentioning that are observed gaps between consumers' stated attitude and their actual behaviour. Even if a strong positive attitude could lead to a purchase attitude of vertical farming products, the true behaviour could differ from these intentions. The results are displayed in Table 2.

5. Discussion

This study aimed to provide insights regarding the acceptance of vertical farming among Danish consumers. The analysis based on the TAM suggests that perceived sustainability is the most crucial driving force for consumer acceptance of vertical farming. The more sustainable the system is considered, the easier it is for the consumer to perceive the whole system of VF as useful, purchase the product and finally embrace this new technology as an entire method of producing food [55]. The findings that show food choices influenced by sustainability are validated and aligned with previous studies in the field [56,57]. Over the years, the concept of sustainability has gained a lot of attention due to the increasing number of people that consider such systems environmentally friendlier compared to traditional agricultural methods [6]. Although it is a quite known topic, people do not consider that their dietary preferences or food choices have a certain environmental impact, so they do not pay much attention to their consumption behaviour [58,59]. On the contrary, previous research showed that consumers are highly interested in following a healthy diet [60]. This evolvement reflects on the importance of environmental friendliness.

Moreover, the acceptance of Danish consumers was found to be lower compared to Germans consumers based on the empirical and model analysis. The results show that people are not aware of vertical farming and are still very sceptical about the quality of products coming from this type of growing system. The constructs include statements related to environmental friendliness, which are highly related to the concept [60]. The concept of environmental friendliness is gaining importance worldwide, and in this regard, many youth movements, such as “Fridays For Future”, urge policymakers to take climate change seriously [61]. Despite having little knowledge of VF, the majority of the young participants showed concern for the environment and replied that they would pay more for environmentally friendly products. However, their buying habits were not aligned with this statement, and very few people had actually bought VF products themselves.

Survey—Focus Group and Analysis

The conducted focus group and survey revealed that for most of the participants, the perceived sustainability is the main driver for vertical farming acceptance. This actively demonstrates that sustainability and efficiency are two key factors in promoting the approval of VF (Survey—focus group in the Appendix A). Furthermore, the acceptance is dependent on the overall sustainability of the system, which, in the case of VF, is not guaranteed. People do not consider these systems sustainable because they use artificial LED light and enriched supplements of nutrient solutions rather than sunlight and natural soil, making them look estranging and less natural. Moreover, consumers have not seen these systems in the vicinity, and only a few have prior knowledge on the topic, which negatively impacts the acceptance of such systems. Consumers usually assume that if they have not seen such systems in their locality, they are not very useful or even sustainable [19]. As a result, their perception of vertical farming is negative, and they would rather stick to the traditional way of farming. Thus, many of them consider vertical farming as a possible alternative for a future solution due to its efficiency and environmentally friendly method of producing food (Appendix A) but not as a solution that can be implemented in the present time. However, even participants who already had prior experiences associated with vertical farming may still consider it an unsustainable food production method. Therefore, subjective knowledge seems to have no significant impact on the perceived usefulness of vertical farming methods.

Some participants were also willing to pay more due to environmental and sustainability reasons, but then when asked if they would pay 15–30% more than usual, they were uncertain. However, when the consumers were informed that VF products could cost three times more than traditionally grown crops, according to a study by Avgoustaki and Xydis [34], none of them was willing to pay that much (Appendix A).

Based on the results, one can observe that the perceived usefulness is not influenced by the environmental concerns towards the particular agricultural method. However, the

respondents rated that they are interested in environmentally friendly products that have low levels of fertilisation [62,63]. This could be greatly beneficial to vertical farms since one of their main characteristics is the absence of contaminated soil from their production lines. Additionally, consumers do not consider vertical farms as an alternative solution towards traditional farming; thus, it does not affect the perceived usefulness. For example, the cultivar species that can be produced in vertical farms are still quite limited compared to conventional farming [50].

Moreover, the perceived usefulness of such systems is a major contributing factor to the buying-to-buyer attitude. This is because people tend to favour locally grown food by recognising naturalness, safety and the absence of chemicals as important drivers of their food choices. Consumers generally care about environmental and ethical issues, and they should be taken into consideration when developing and communicating innovations in the food market [64]. In the case of vertical farming, the public's awareness and knowledge of the nutritional value of the food products could play an important role in their acceptance [65]. However, at the same time, consumers consider this system artificial, which makes the overall acceptance of this setting doubtful, indicating that naturalness can be a critically important factor in the perceived usefulness of the method [66]. The attitude towards buying can positively influence the behavioural intention to buy a product. Previous publications indicate that consumers prefer natural and traditionally made products over artificial ones or products they cannot fully understand their production methods [67,68]. Vegetables inside vertical farms grow with the support of artificial light and the total absence of natural sunlight with soilless cultivation techniques [42]. These growing conditions may appear unnatural at first; however, it should be stressed that inside controlled-environment agriculture, plants grow under the total absence of chemical inputs (herbicides, pesticides). Under this scope, the growing fruits and vegetables do not come in contact with chemical inputs; thus, the consumers' demand for naturally cultivated products could be met. Perceived behavioural control does not seem to have a major impact on the attitude towards buying; however, it can slightly impact the behavioural intention to buy. The statements included in the perceived behavioural control could cause an overload of information that consumers are not able to process and could lead to confusion and denial [69]. The results indicate that consumers do not embrace extreme positions, meaning that they do not have a clear intention on whether they should buy and support VF products or not. One explanation for their position is that they do not have sufficient knowledge and information on the specific production system and thus no experience with the products. Another reason could be the distrust towards new technologies and products until they gain publicity and public acceptance, which, in this case, is the avoidance of buying or eating new food [70].

Similarly, comparing the results of our research with the previous research conducted on German consumers showed that consumers in Denmark have concerns about VF, and they are less likely to accept the change compared to their German counterparts [51]. Moreover, their interest in investing in VF is on the lower side as well, which also shows that the acceptance of this technology is not high enough. In Germany, people are still sceptical of VF since they are not ready to accept these new growing techniques and methods. Most importantly, they are also less aware of how such systems work. Still, the perceived usefulness of VF by Germans is higher compared to consumers in Denmark. This is because there is more infrastructure related to these farms developed in the country compared to Denmark, which makes it more tangible and therefore acceptable by consumers [50].

Overall, the acceptance of the vertical farming concept is an evident obstacle due to the misleading perception that VF is equal to an artificial method of food production. A study by Curtis [47] also demonstrates that it is not only on a business-to-consumer (B2C) market, where the identity of vertical farming is presumed negative. In London, some restaurants use VF but are afraid to promote it due to consumers' perception of it and the possibility that it could interfere negatively with the sales potential [71]. This leads to the main obstacle of acceptance and perceived sustainability through the lack of

awareness [56]. In order for VF to successfully penetrate into the market, their perception needs to be converted from something artificial (and subsequently negative) into something positive and environmentally friendly. To minimise this restraining fear arising from vertical farming, the awareness of the benefits and positivity of VF needs to be stressed, e.g., emphasising benefits, such as the usage of less water, fewer pesticides, herbicides, etc. Furthermore, a clear advantage of VF that should be highlighted is that the products grow in healthy environments with lower chances of contamination and other latent pollution. Therefore, it could be concluded that VF companies should develop marketing and communication strategies on the sustainability aspects of VFs in order to enhance consumers' perceived sustainability and attitude towards buying and, finally, increase peoples' behavioural intention to buy.

6. Conclusions

Vertical farming is a new sustainable farming method that has gained popularity around the world. However, by contacting a focus group and conducting a survey on Danish consumers, it can be concluded that there is a lot of distrust and negativity towards VF due to the lack of awareness and proper information of the public.

The final construct shows that consumers do not intend to assume extreme positions, i.e., they are not clear on buying vertical farming products and also unsure about recommending them to their community. Additionally, the TAM analysis shows that sustainability is a major aspect that controls consumer acceptance. Danes are open to investing in VF technology, but their acceptance is relatively lower compared to German consumers. Therefore, establishments investing in VF in Denmark need to market and promote it through various channels so that people can become familiar with VF and its benefits. Thus, changing their attitude towards buying VF products should happen gradually before promoting the use of vertical farming in order to alter consumer attitudes with higher levels of acceptance of the new technological food production method.

Another aspect that Danish consumers are sceptical about is the level of technological advancement that makes the farming process artificial without real sunlight, compared to traditional methods. Nonetheless, the dissemination shows that having a more elaborate understanding of vertical farming could be beneficial for Danish consumers and that a more sustainable future is accessible with the relevant discussions and critique points.

Future research is necessary to reveal how consumer attitude and acceptance could change over time when vertical farming starts becoming more popular in Europe. Additionally, a life cycle assessment on different vertical farming systems and infrastructures could provide meaningful insights on how customers assess sustainability. Finally, higher sampling distribution and further analysis on other European countries would provide more meaningful information concerning the consumers' attitudes on this novel technology. Additionally, it is important to mention that due to the consumers' limited acceptance and attitude towards buying and supporting vertical farms, it is of vital importance for the future success to spread and keep the technology in the market, enhance the information and knowledge and place VFs as a marketable solution in the problematic open-field food production.

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Appendix A

Focus Group and Survey

We have conducted a focus group and survey with 10 randomly picked participants from Denmark to obtain a more accurate idea/precise view /picture of what the Danish consumers think about VF and what opinions and attitudes they have regarding VF. The focus group was verbally conducted through Zoom due to COVID-19 restrictions.

Constructs	Question	Statement/Indicator	Percentages
Attitude towards sustainability	How much do you care about sustainability?	"Very much indeed, because I prefer my food being in less contact with chemicals, which is why I buy organic food now." "I care for eco-friendly and sustainable food products because of health and environmental reasons" "I really don't care that much I just buy the cheapest available" "I don't think about sustainability because it doesn't taste differently compared to the way it is traditionally produced, so I think it is only a branding issue."	Yes: 60% Maybe: 10% No: 30%
Subjective Knowledge	How much do you know about vertical farming?	"I have just come to know about through some family" "I have known about it for some time because I have considered applying it"	Yes: 50% Maybe: 10% No: 40%
		"I am a farmer myself but I also like how technology up to date is making everything more efficient" "I think it's fake, and is a disgrace to the natural way of producing food." "I know about due to environmental reasons and I love the fact its more efficient and a new solution on agriculture"	
Subjective norm	What would people from your close social circle think of you buying vertically farmed products?	"My family would approve, because we all eat organic and are environmental aware." Yes, my friends would approve if I supported an environmental cause and thereby would purchase vertically farmed products" "I think my colleagues would approve."	Yes: 60% Maybe: 10% No: 30%
Perceived sustainability	Do you believe vertical farming is the future of agriculture?	"Yes, as far as my knowledge go, it could work pretty efficiently." "Yes, I think it may be a solution." "Yes, technology is the future solution for most things so I think we have to keep up the innovation." "No, I think we should keep it the natural and traditional way."	Positive: 40% Not sure: 30% Negative: 30%
		"I'm not sure that a technology based method, would be a long term solution."	
Attitude towards buying	What do you think about vertically farmed products?	"I think it's a new and innovative idea." "I wouldn't mind eating it; I only see it as an efficient way for the future" "I would stick to the cheapest price" "I would consider it, but not for now, because I would rather stay with the organic way." "I think it's too artificial."	Yes: 40% Maybe: 30% No: 30%
Perceived behavioural control	What stops you from buying vertical farmed food?	"I have a habit of just buying the cheapest" "I love organic food though" "No, it's too artificial, without real sunlight and comes from soil. It is looks more like food from a lab." "I really don't mind trying it, but I'm also not eager to try it out."	Yes: 20% Maybe: 20% No: 40%
Behavioural intension to buy	Would you buy it, if it cost more than you usually use?	"Yes if it is worth it" "yes, of course, as long it gives me what I need"	Yes: 40% Maybe: 30% No: 30%
	Traditional or organic food?	"No, I would stick to the cheapest price" "I would consider it, but not for now, because I would rather stay with the organic way."	

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