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Social Value of Urban Rooftop Farming: A Hong Kong Case Study

Ting Wang and Mathew Pryor

Abstract

As cities densify, areas available for agriculture within the city become increasingly small and infeasible for mass production. In parallel, many cities have seen a rapid rise in establishing community-based micro-farming, operating within marginal spaces of uncertain ownership or regulations. Prominently in Hong Kong, more than 60 urban rooftop farms have spontaneously appeared in the last 10 years on buildings. High application rates for renting plots in these informal farms suggest a strong demand in the population. Motivations cited by participants of rooftop farms are typically social, although social values have yet to be specifically defined or objectively measured. Hong Kong Special Administrative Region Government's new agricultural policy conceives urban agriculture as a commercially productive practice. In consequence, urban rooftop farming lies awkwardly between formal city planning and informal community practices. A study of five rooftop farms in Hong Kong found, through participant opinion surveys and cost-benefit analysis, that the social benefits to participants were multifaceted with a preference on personal socialization and that they were willing to pay for the experience. The results suggest that if the products of rooftop farming could be conceived as being social, rather than food production, individual motivations and state interests could be aligned and the available roof space activated to achieve a more sustainable city.

Keywords: urban agriculture, rooftop farming, social benefits, sustainability, cost-benefit analysis

1. Introduction

With the intense contest for ground-level space within high-density urban districts, urban agriculture has taken on multiple forms and occurs in different locations, such as peri-urban farming, urban soil-based farming, indoor farming and rooftop farming [1]. Urban agriculture was initially conceptualized as a response to increasing concerns for food security within the city, with the focus on the potential for mass production within a localized food system that includes production, processing, distribution, consumption and recycling [2]. More than 30% of the food requirements of the City of Oakland are planned to be provided from within the physical limits of the city through city council's sustainable food system [3]. However, within the complex morphology of high-density cities, the contest for space and strict land use and building controls, the large-scale contiguous spaces required for economic mass agricultural production are seldom available. Many micro-farming enterprises, however, have emerged in cities around the world as community gardens and allotment gardens [4]. Occupying small-scale,

marginalized and fragmented “leftover” spaces, these occur on sites of uncertain ownership and ambiguous regulatory control.

A clear expression of this phenomenon is the spontaneous appearance in the last decade of more than 60 rooftop farms on underutilized flat roof spaces across the dense urban districts of Hong Kong [5]. These urban rooftop farms are composed of numerous lightweight surficial planter boxes (as opposed to the built-in planting constructions typical of green roofs) which are individually rented to the general public through community enterprise organizations or provided to relevant groups by corporate or institutional owners. Proximity to the people’s living and working spaces have made urban rooftop farms popular, with all farms reporting that they are constantly heavily oversubscribed. Farm owners have suggested that the strong demand for participation is motivated by the opportunities it provides for social interaction, passive recreation, health, education and self-achievement. This contrasts with the HKSAR Government’s recent policy initiatives for urban agriculture which are focused on economic and productive values [6]. In consequence, urban rooftop farms in Hong Kong are in an ambiguous situation between formal centralized city planning and informal community enterprise action. To understand the social benefits of rooftop farming within an urban context of contested space and extreme land value, this study looked to monetize social value through cost-benefit analysis and willingness among participants to pay for extra social benefits derived from the practice.

1.1 Social value of urban rooftop farming

Social value has long been a consideration within environmental justice discourses; however there has been relatively little research on the social values of urban agriculture and almost none on urban rooftop farming [7]. As with urban agriculture, the few policy debates that have occurred on urban rooftop farming have focused on the potential economic value—the monetary profits that might be generated by selling food produced within the city and generalized concerns for global food security. Around the world, however, very few large-scale commercial urban rooftop farms have been successfully established, and these have only been achieved by retrofitting rooftops with large-scale greenhouses, e.g., AeroFarms in the USA [8] and urban farmers in the Netherlands [9]. The large majority of urban rooftop farms have been small-scale social and community enterprises. In recent years, discussion about the practice has migrated onto to potential contribution to urban environment and greening [1, 10–13]. Urban rooftop farms have been suggested as possible patches that might visually and ecologically link existing green spaces and corridors within an integrated green infrastructure system and help mitigate urban heat island effects [14]. It has been shown that urban rooftop farms support far higher biodiversity (some have upwards of 200 plants species) than green roofs [15].

Only recently have discussions of the social values of urban rooftop farming begun to appear in the literature. Although social values are considered an important principle within broader concepts of urban sustainability, their recognition and development are lagging [16]. This is commonly attributed to the fact that social values associated with the external environment, such as green spaces and allotment gardens, are intangible and difficult to measure [17]. Social value is usually assumed to be generated through communal physical activity within a space, for example, social groups collaborating on planting activities [18]. Long return on investment makes social value hard to calculate and difficult to monetarize, metrics that are commonly required for inclusion in policy decision-making [19].

Through a review of international case studies, social values of urban rooftop farming were initially investigated from three aspects: social capital theory,

landscape projects and urban agriculture practices and with the aim of building a systematic framework of social values for urban rooftop farming. As Dika and Singh [20] noted, the decomposition of a broad concept into factors and indicators can improve understanding and help the policy adaptation in specific contexts.

Ideas of social values are based on social capital theory which focuses on balancing different social groups by creating a sense of fairness from collaboration [21]. Social group integration and empowerment are key factors discussed by scholars. Dubos [22] suggests that social capital should be considered in two forms: structural network and cognitive value. Doherty further explains that the structural network in an inclusive society should cross generations and identities and consist of the behaviour-related indices of trust, informal networking, mutual support, reciprocity and solidarity [23, 24]. At the same time, cognitive value is a significant assessment for empowered citizens which is usually obtained from increasing self-satisfaction, achievement and leadership in the society [25, 26].

As an emergent landscape typology, performance measures for urban rooftop farming have yet to be developed [27]. Methods of measuring performance of built landscape have tended to assess physical objects and functional efficiency [28, 29]. Of the few approaches that have evaluated changes in social aspects, Landscape Performance Series (LPS) and Case Study Investigation (CSI) contain the most instructive framework, as they categorize recreation, health, education and food production as core social value factors that enhance sustainability in landscape projects [27].

In the absence of previous research on the specific social values of urban rooftop farms, this research drew upon discussions of social values related to urban agriculture in general. This allowed indicators for an urban rooftop farming social values framework to be identified. The urban agriculture matrices framework developed by Design Trust for Public Space program in New York highlighted the significant benefits through increased physical health and social empowerment from growing vegetables [30]. Specifically, physical, mental and dietary health can be summarized from the research outcome. Social empowerment has been further supported via environmental and food education, leadership and socializing activities which are increasingly important by-products of all forms of urban agriculture. Other researchers have identified unique collective social welfare being generated through urban rooftop farming [7, 31, 32]. Tian and Jim addressed the social value of additional open spaces to the surrounding communities through multifunctional roof spaces, noting that given the limited land in highly dense cities, retrofitting urban farms to rooftops can effectively activate large numbers of vacant spaces within the city for social benefits [32]. Prior research studies have also indicated that dynamic factors are involved in the generation of social values through the practice of urban agriculture.

1.2 Framework of social benefits of urban rooftop farming

Based on these interdisciplinary research studies, a social value framework for urban rooftop farming was developed, specific to the Hong Kong context (**Table 1**). This allows a spectrum of social benefits of urban rooftop farming to be considered, with respect to the diverse stakeholders' (state and individual) interests. The framework compares the social values generated by urban agriculture, green roof installations and rooftop farms; identified from published research papers; and categorized under six factors: health, education, community recreation, urban improvement, social empowerment and social group integration. Urban rooftop farming generates the greatest amount of activity across all the different social values.

| URF social value framework | | | | | |
|----------------------------|------------|---------------|-----------------|--------------------------|--|
| Urban agriculture | Green roof | Rooftop farms | Category | Factors | Social benefits |
| ✓ | | ✓ | Social benefits | Health | Improve physical health |
| ✓ | | ✓ | | | Improve mental health |
| ✓ | | ✓ | | | Experience health habit and diet |
| ✓ | | ✓ | | Education | Increase environmental awareness |
| ✓ | | ✓ | | | Promote sustainable living |
| ✓ | | ✓ | | | Increase organic food knowledge and demand |
| ✓ | | ✓ | | | Gain practical skills by working in urban rooftop farms |
| ✓ | ✓ | ✓ | | Community recreation | Provide extra open space for communities |
| ✓ | ✓ | ✓ | | | Provide visual aesthetic value |
| ✓ | ✓ | ✓ | | | Increase space using comfortableness |
| ✓ | ✓ | ✓ | | Urban improvement | Serve as a planning tool to fill vacant spaces in cities |
| | ✓ | ✓ | | | Extension of the life expectancy of roofs |
| | | ✓ | | | Diverse the multifunctions of roof spaces |
| | ✓ | ✓ | | | Good for urban or building retrofitting |
| ✓ | ✓ | ✓ | | Social empowerment | Improve users/residents' life satisfaction |
| ✓ | | ✓ | | | Enhance community participation |
| ✓ | | ✓ | | | Develop leadership |
| ✓ | | ✓ | | | Provide job opportunity to communities |
| ✓ | | ✓ | | Social group integration | Empower marginalized groups |
| ✓ | | ✓ | | | Enrich aging life |
| ✓ | | ✓ | | | Enhance parent and children relationship |
| ✓ | | ✓ | | | Form social networks |
| ✓ | | ✓ | | | Create social solidarity among diverse groups |

Table 1.
Social value framework for urban rooftop farming.

2. Hong Kong urban rooftop farming in a high-density city

Within HKU’s broad-based “edible roof” initiative which examined the rooftop farming phenomenon across Hong Kong, this specific research study examined eight urban rooftop farms within Hong Kong (including enterprise, social enterprise and individually oriented modes) to determine the nature and scale of the social values that urban rooftop farms could generate.

Hong Kong is an extreme example of high-rise high-density urban settlement, with severe contest for ground-level space, very high land values and a passive governance structure. Although HKSAR Government's New Agricultural Policy 2014 and Hong Kong 2030+ strategic planning statement do acknowledge urban rooftop farming practices within the general concept of urban agriculture, intention has focused primarily on economic productivity, and no specific institutional, regulatory or technical support is offered to the small-scale grassroots organizations that practice farming. Despite this, more than 60 urban rooftop farms have spontaneously appeared in the city since 2008 covering some 15,000 sqm of previously underutilized roof space [5]. The majority of the farms are located on industrial or institutional buildings within the older urban districts (**Figure 1**). Based on a definition of the physical and operational limits of rooftop farming practices and subsequent suitability assessment of all existing buildings in the territory, the potential farmable roof spaces that might exist within the city have been estimated at approx. 595 ha [5]. Although typically small-scale and disparate, these spaces are all in close proximity to large urban populations and collectively offer an expansive opportunity for generating social value (and its attendant economic advantages) if activated for rooftop farming [33].

Physical and operational characteristics of the three modes of urban rooftop farming in Hong Kong were identified through systematic site survey and typological study (**Figure 2**). Social enterprise farms aim to promote social change through a sustained commercial business [34]. Social enterprises, such as City Farm and Fun n Farm, generate social impacts by renting out the planting plots to the public. Planting plots typically consist of shallow free-standing black plastic crates filled with lightweight soil, with bamboo or plastic pipe frames above supporting screen netting [33, 35]. Crops are selected and taken care of by farmers, although daily watering is undertaken by farm managers. Training courses (for different skill levels) and related social and craft activities are commonly offered. Farmers rent any number of boxes per month, depending on their ambition and commitment. All farms report extensive

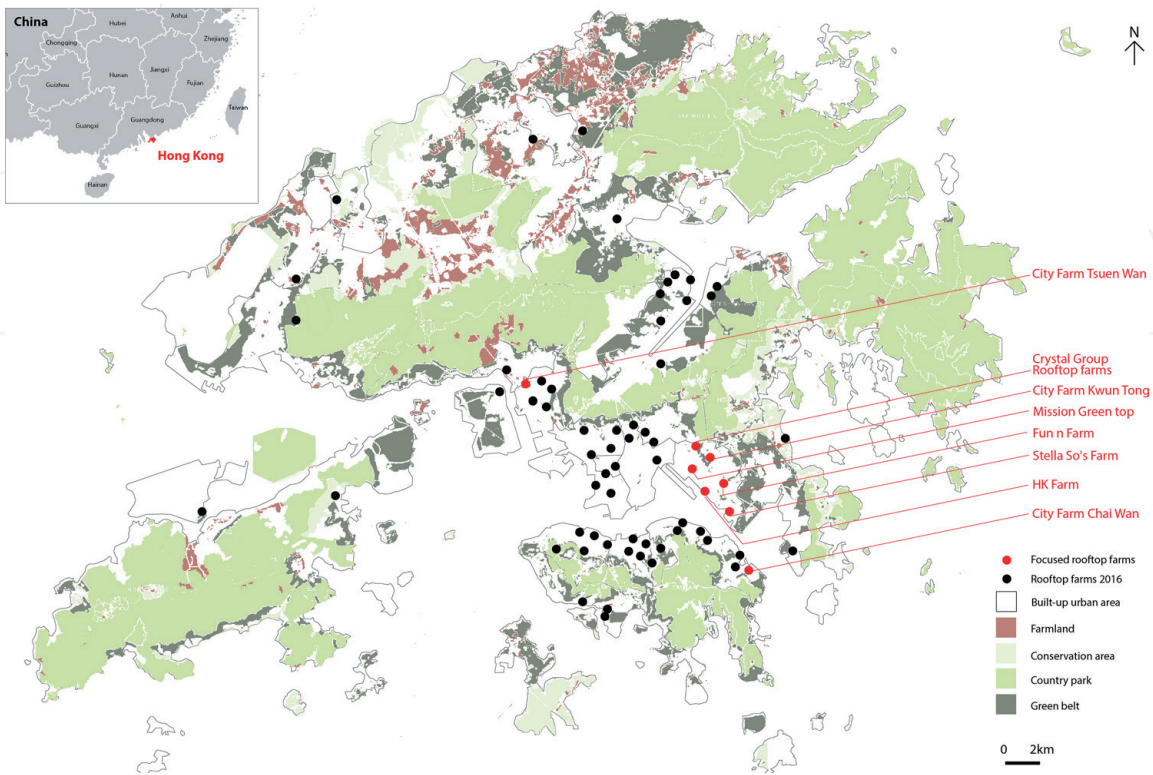


Figure 1.
Locations of urban rooftop farms in Hong Kong, as of 2016 (data source: Mathew Pryor ongoing research and Google earth).

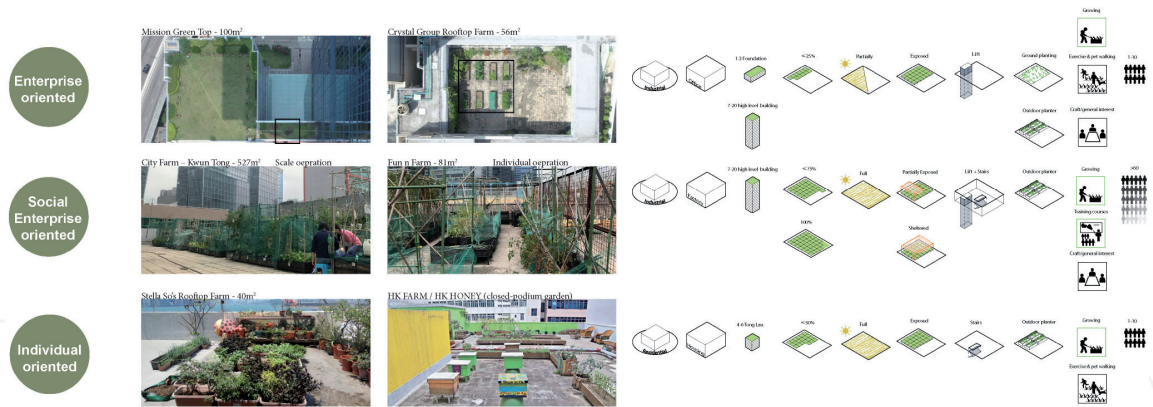


Figure 2.
Typological study of urban rooftop farm in Hong Kong (photo taken by Mathew Pryor and ting Wang).

waiting lists. The depth of soil and exposure to wind limits species choice to some extent, but a wide range of leafy greens, climbing plants, root vegetables and herbs can be grown. Enterprise-oriented farms are operated by private companies and business or large institutions (universities, schools, hospitals) located on their own premises. Access to the farms is restricted to employees or institutional members. They are similar in physical form and nature to social enterprise farms but additionally provide leisure and social space for employees, with tables, chairs, etc. Individual rooftop farms were very small-scale and only found on residential buildings. Their form was typically more complex and less ordered, and both the form of the planter and the crop species were far more diverse. As they depend solely on the individual owner's willingness and availability, they were seen as being more vulnerable.

3. Research design

Based on this understanding of the local context, the research study was structured around a participant opinion survey and semi-structured interviews with the operators from five selected farms. The survey aim was to validate the preliminary urban rooftop farming social value framework and to quantify the intangible social values from the perspective of the users, including those with and without experience of farming. Subjects were randomly selected from the five farms and from the surrounding residential communities, respectively. A total of 108 answers were collected.

Semi-structured interviews were conducted with farm operators from the five farms, in order to understand the monetary influence of social values in urban rooftop farming and to verify the findings from survey. Questions focused on topics such as modes of operation and costs, as well as physical arrangement and planting types. Farm cost data was used in cost-benefit analysis and “willingness to pay” based on contingent valuation methods and perception preference methods. As willingness to pay is influenced by the perceived utility, personal preference of use and socioeconomic environment of the subjects, the survey was designed to obtain the information about various degree of willingness and payments, preference of social values developed in framework and personal socioeconomic information including gender, employment, education and income levels.

4. Findings

The majority of respondents (77%) perceived social values to be the most important benefits of urban rooftop farming, compared with environmental values

(58%) and economic benefits (10%). Women and the middle-aged (30–50) were found to be the predominant users of urban rooftop farms—by both number and time. This finding was confirmed through farm membership records and observations of farm managers. Meanwhile, the majority of farm participants were from middle- to high-income groups.

4.1 Social values with a preference for personal socialization

The perception of social values was complex, with individuals expressing degrees of perception toward the six different factors (Figure 3). However, personal socialization benefits were identified most strongly among the six factors. Health (53%) and education (62%) were the factors most perceived by respondents that directly link to the personal enhancement in social statues. Planning social welfare (40%), social group integration (40%), community recreation (35%) and social empowerment (25%) were of less importance by respondents.

Disparity of social benefit preferences reflects the difference between personal experience values and group conceptual values. Personal health and education are the most direct feelings obtained through daily activities; however, individuals perceive larger scale community and collective benefits indirectly. For instance, though social group integration was not perceived as very significant on the whole, the indicators for enriching the life of the aged and enhancing intergenerational relationships were perceived as highly significant because of the close personal feelings attached. “Developing leadership” and “providing job opportunities”

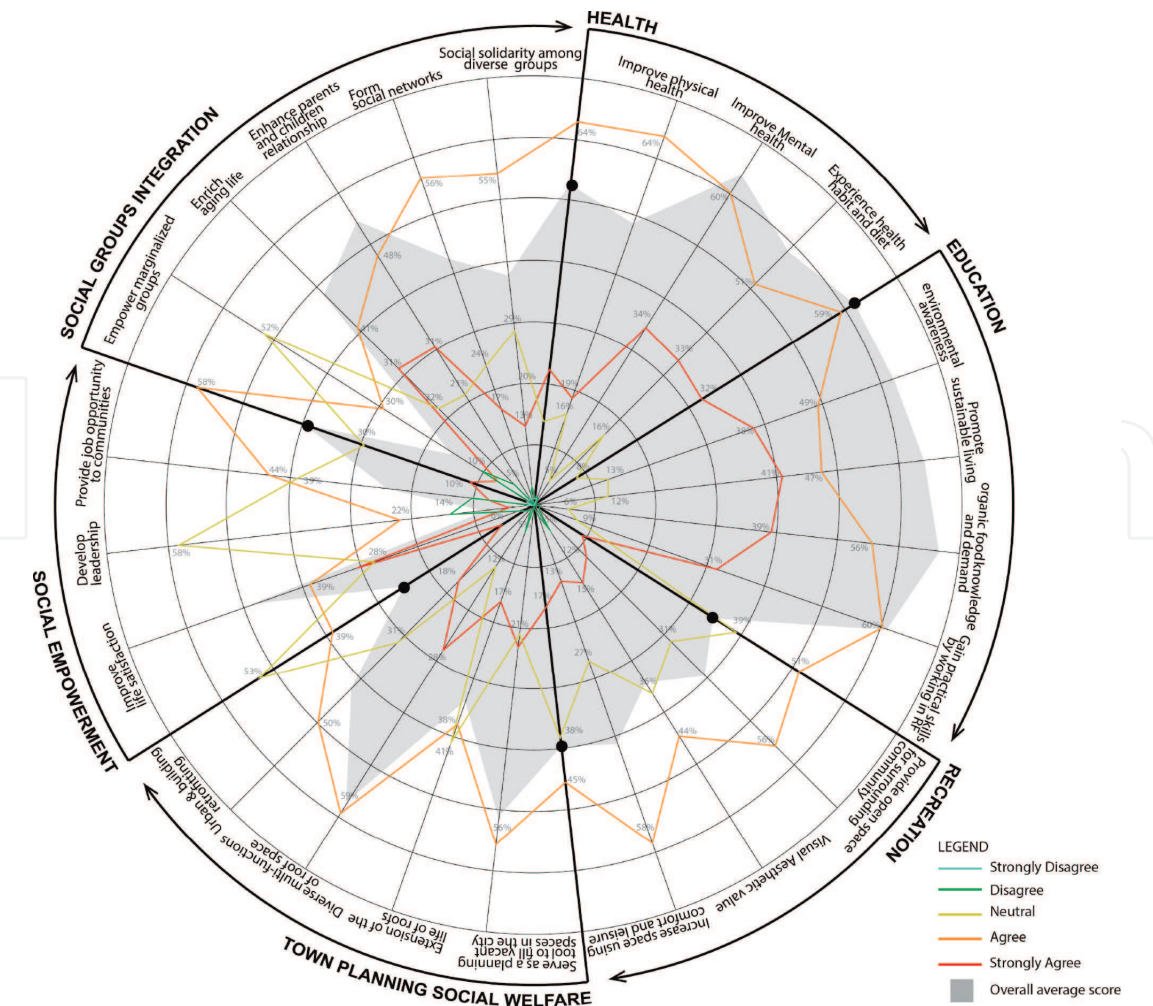


Figure 3.
Perception distribution.

were the two least important indicators among the social empowerment factors, in interview participants questioned “how can leadership be improved by just growing vegetables?” To some extent, this makes sense because it is hard for leadership development to be perceived by the users themselves unless there is an external instructor who guides the activity and highlights the purposes behind it. This may necessitate long-term observation of farm participation organized by experienced teams or working feedback from the employment company. At this point, there is no measurable index for conceptual benefits. In addition, the benefits of increased job opportunities for the society will only be realized when urban rooftop farming becomes a city-scale endeavor. Current rooftop farms are individually too small to be measured in the employment indicator.

4.2 Willingness to pay for social benefits

Many respondents indicated willingness to pay for the social value experience derived from urban rooftop farming. While some were conservative about payment, “I don’t have extra time to enjoy the rooftop farms” (32%); “I cannot afford to pay or buy the service” (19%), the majority of respondents (87%) were willing to pay. The average payment reported during the survey was HK\$ 220 per month/person/half square meter. In comparison with the current charge for renting a plot in an urban rooftop farm (HK\$ 190), this suggested an increased perception of social values among users.

Just asking questions about individual payment decisions encouraged respondents to consider the benefits and the maximization of utility. Willingness to pay was found to be related significantly to the degree of understanding of urban rooftop farming, level of education and income level. Willingness to pay increased with the cognitive level of participants from “no idea” to “have participated in urban rooftop farming.” Practicing farmers were willing to pay more (HK\$ 232) than those that had not previously participated (HK\$ 194). Most of the respondents who are willing to pay were from higher levels of education (undergraduates and graduates), as well as higher-income groups (**Figure 4**).

4.3 Cost-benefit analysis: The monetary influence of social values

Apart from the multiple implications of social values in urban rooftop farming, this research also demonstrates the potential monetary influence through the application of cost-benefit analysis in comparing the marginal benefits (social values) with the existing benefits and costs (capital and recurrent). According to [25, 36], the following cost-benefit analysis components can provide an economic spectrum of social values in urban rooftop farming which can influence government decision-making and contribute to social well-being:

$$\text{Gross costs} = \text{Capital costs} + \text{Recurrent costs} \quad (1)$$

$$\text{Gross benefits} = \text{Recurrent benefits (or any other marginal benefits)} \quad (2)$$

$$\text{Net Benefit} = \text{Gross benefits} - \text{Recurrent costs} \quad (3)$$

$$\text{Cost and Benefit ratio} = \frac{\text{Gross Benefits}}{\text{Gross Costs}} \quad (4)$$

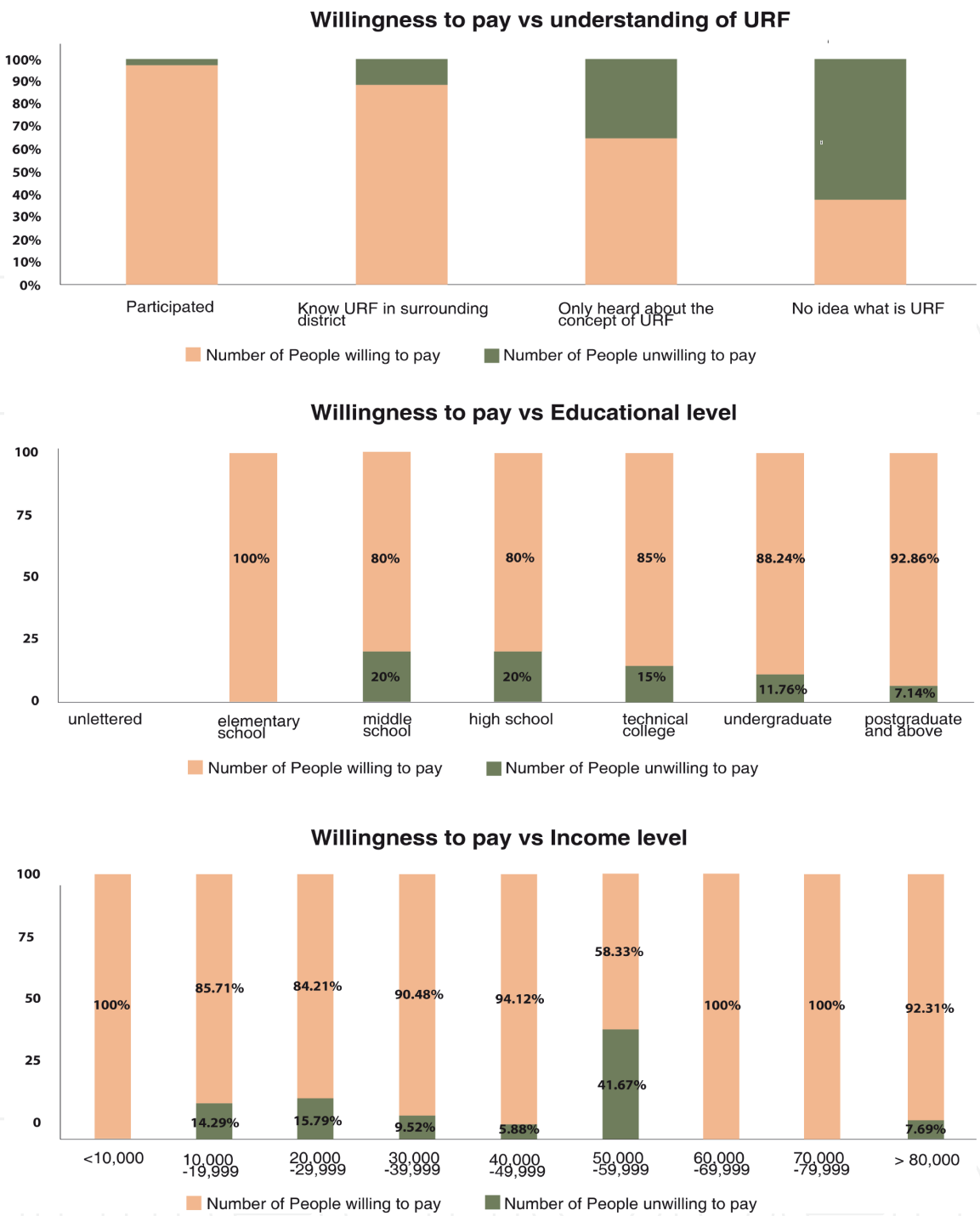


Figure 4.
Significant factors in willingness to pay.

$$\text{Payback Time} = \left(\frac{1}{\text{Cost and Benefit ratio}} \right) * \text{one year} \tag{5}$$

$$\text{Net Present value} = \frac{(\text{Net Benefit} * (1 - (1 + \text{Discount Rate})^{-\text{project period}}))}{\text{Discount Rate}} \text{Capital costs} \tag{6}$$

Among the financial information obtained from operators, City Farm Kwun Tong was chosen as a prototype for this calculation due to its comprehensive operational mode and representativeness of other farms in Hong Kong. Cost-benefit analysis in the study used the basic scenario of a rooftop farm in Hong Kong. The prices and amounts were all generic estimates in order to provide the minimum costs and benefits.

First year revenues generated through urban rooftop farming were found to barely offset the costs in Hong Kong. In the prototype case, the gross costs and benefits of urban rooftop farming in the first year were HK\$ 730,400 and HK\$ 764,760, respectively. In subsequent years, the annual recurrent commercial benefits exceeded the annual recurrent costs HK\$ 530,400, giving a benefit-cost ratio of 0.32 (234,360/730,400), which suggested a likely payback period of 38 months. This factors in the high initial capital cost to establish a rooftop farm which includes building retrofitting costs and the purchase of equipment. Farm managers reported that the business stabilized after the second year and revenues were expected to increase in a long term.

However, the current amount of payment is based on a narrow view of farming participation (HK\$ 190 per month/person/half square meter). As suggested by the willingness to pay analysis, once participants took into account the social values derived from their farming activities, they might be willing to pay more (HK\$ 220). If fees were raised to this level, it would significantly alter and increase the gross benefits (to HK\$ 872,760 per year) and shorthorn the payback period (to 26 months). The results suggest that cost-benefit analysis provide a useful basis on which to reconceive the financial viability of the urban rooftop farms.

5. Discussion

In Hong Kong, formal green initiatives in the urban area have come a long way from the development of public parks in the 1970s to the promotion of green roof designs through sustainable building directives in the 2000s. However urban rooftop farming has not been formally recognized and exists still within gray areas of urban planning legislation and building control.

As evidenced by these findings, the disparity of multifaceted social values aligns with previous literature on social capital theory. Cognitive values are directly related to the individuals in the society such as the effects of health and education improvement, while structure values are indirectly built through expanding network in society which needs more efforts to achieve. For instance, collective assets like the urban economy prosperity and social solidarity not only improved by mobilizing individuals through urban rooftop farming but also need more complex catalysts.

Different levels of understanding of social values have been identified within previous landscapes value research [37]. Individual perceived values in the landscape, concentrating on health and general wellbeing, have most readily been identified: collective values relating to spatial planning and resource management have been less mentioned by subjects. This disparity is also rooted in the physical nature of existing urban rooftop farming practices. According to observations made during this research, rooftop farming activity is explicitly individual due to space limitations. A large number of planting plots were arranged side by side within physically constrained roof spaces, inhibiting interaction. Participants work by themselves on individual plots while only “keeping an eye” on surrounding plots farmed by others. This mode of operation might explain the higher perception of direct personal health and education benefits. The lack of additional social space in social enterprise farms and the solitary nature of individual farms may reduce perceptions of collective social value such as engagement of the community or improvement of the urban environment.

Previous research has not explored the monetary influence of social benefits, which is required for urban rooftop farming to be incorporated into urban policy-making. For instance, on average the payback period for farms is shorter than for green roofs in Hong Kong (27 months) and for ground-level urban agriculture

projects (96 months) [25, 38]. The monetary influence of social values is likely to become amplified as urban density increased. Governments, as well as building owners, are likely to be more willing to invest in urban rooftop farming for both the economic benefit and social value through community sustainability.

6. Conclusion and further research

A shift in the thinking about the products of urban rooftop farming from food security and urban greening to social benefits and positive support to activate urban rooftop spaces would create significant opportunities for aligning individual motivations and state interests, thereby achieving a more sustainable city. Though current urban rooftop farming is undertaken by individuals and grassroots organizations, with limited policy or technical supports from city authorities, users still perceived considerable social benefits in the form of sustainable living, environmental knowledge and enhanced relationships within social groups. Users' willingness to pay for the experience indicates that urban rooftop farming is a passive social activity which can be enhanced by collaborative activities and by-products of farming which include talking, working side by side, standing and comparing.

The implication of the multifaceted social values of rooftop farming suggests a changing perception of urban agriculture. With the increasing speed of urban densification, urban agriculture, constituted by complex social values and diverse interests from stakeholders, has the capacity to be a public good for cultural exchange and enhancing social coherence. This changing perception suggests the need for greater stakeholder support, recognition in legislation and integration with urban planning and building control processes. As an emerging urban activity, further studies are required. For instance, the higher preference for health and education as social benefits in this research requires more specific study to develop detailed instruments for those single indicators within particular groups. In addition, as this study only addressed the social values of urban rooftop farming in Hong Kong, further studies in different contexts and forms could help to expand the urban agriculture discourse.

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Appendices

List of semi-structured interview questions:

- 1.1. When was your rooftop farm built?
- 1.2. How was your urban rooftop farm established? What kind of costs is included in the farm? Can you give me the rough number about the cost?
- 1.3. How does your farm operate on a daily basis? How many people did you hired and in what position? What kind of benefits can be earned in the urban rooftop farm? Can you give me the rough number about the benefits?

- 1.4. What are the difficulties you faced when setting up an urban rooftop farm in Hong Kong?
- 2.1. How big is your urban rooftop farm?
- 2.2. What kind of activities you have in your farm?
- 2.3. Can you estimate roughly how many people come to your rooftop farm on a regular basis?
- 3.1. What kind of species can you grow in your rooftop farm?
- 4.1. How do you think about the distribution characteristics of the participants in my questionnaire? Is it consistent with your observation every day?
- 4.2. How do you think about the existing result of questionnaire that shows the low perception of the collective social value in URF? Are you considering to add more public spaces or people to socialize in the future?

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