FROM INNOVATION TO SUSTAINABILITY: SURVIVING FIVE YEARS AS AN URBAN AQUAPONICS SOCIAL ENTERPRISE

A Comparative Case Study Analysis of Two Urban Aquaponics Social Enterprises in the Cities of Melbourne, Australia and Milwaukee, USA

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Abstract

Aquaponics is an environmentally sustainable food producing technology that is very adaptable and amenable to both urban contexts and community-led development and capacity building. Community-based urban aquaponics enterprises represent a new model for how local agency can be blended with scientific innovation to increase the food security of cities, re-engaging urban communities in their food production, while minimalising the stress placed on the natural environment caused by unabated urban expansion. Little is known however, about the factors – social, economic and environmental – that determine the success or failure of these enterprises. Addressing that gap, this paper examines stakeholder experiences of building community-based urban aquaponics enterprises. I first draw upon existing food security, social enterprise and aquaponics literature, to identify factors in the related area of community-based urban agriculture. I use a comparative case study methodology, to test for the presence of these factors - and to draw out other unknown factors - in two cases in Milwaukee and Melbourne. In each case study I conduct surveys and in-depth interviews with key stakeholders, exploring their relative objectives, approaches, structures and experiences. Based on these findings, I highlight a number of challenges ‘start-up’ urban aquaponics enterprise are likely to face, and suggest a series of criteria for assessing how those challenges are being met.
Acknowledgements

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I am extremely grateful to Dean Amhaus and his team at the Water Council in Milwaukee who made my trip to the city possible. Having the opportunity to see and meet the people of SWO and the city and culture that surrounds it added a depth to my research that just would not have been there otherwise. I look forward to returning their generosity when they visit Australia.

I thank the UN Global Compact Cities Programme (UNGCCP) for directing me to and supporting me throughout this project. In particular, I would like to thank the Deputy Director, Elizabeth Ryan, whose vision and belief in supporting fledgling researchers in the field of urban sustainability is matched by her determination to take this support beyond simple words. A big thank you too to my friend Felicity Cahill for her patience, support and thorough proofing and formatting expertise.

I would also like to acknowledge my supervisor Dr Liam Magee for his dedication, motivation, guidance and comic relief.
Declaration

I declare that the thesis entitled From Innovation to Sustainability: Surviving Five Years as an Urban Aquaponics Social Enterprise and submitted for the degree of Bachelor of Social Science (Honours) is the result of my own independent research, except where otherwise acknowledged, and that this thesis (or any part thereof) has not been submitted for a degree to this or any other university or institution.

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Julia Laidlaw

11 June 2013
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INTRODUCTION

Globally, the number of people living in cities outnumbered those living in rural environments for the first time in human history in 2008 (FAO 2009). More than ever, the need to create socially responsible and environmentally friendly food productions systems is highly relevant (Koc et al 1999, Viljoen & Wiskerke 2012, Ackerman Leist 2013). The nature of these systems will ultimately depend upon our willingness and capacity to blend the essential social, environmental and economic elements. While debate on the theoretical aspirations of this transition is thriving, projects working 'at the coal-face' of this change can struggle to turn sustainable development theory into a compatible practical reality.

The development of pioneering innovations creates opportunities to learn from their mistakes as well as their strengths and strategies for survival. This, in turn, allows us to identify barriers to their development that might easily be removed once recognised. As I argue below, urban aquaponics, a relatively new and unknown form of urban agriculture, has a role to play in the transition to more socially responsible and environmentally friendly food systems. For many cities, however, this transition will not be easy. Through the study of two urban aquaponics enterprise in different settings, this research seeks to shed light on why sustainable development projects, experiments and enterprises aspiring to global sustainability often struggle to achieve operational sustainability in the practical sense. At the same time, these cases also make it possible to identify elements required to foster the development of community focused urban aquaponics enterprise.

Urban agriculture can serve to alleviate stresses caused by runaway population growth, rising fuel costs, environmental degradation and an increasingly centralised global food system (Mougeot 2007, Patel 2007). In the current surge of interest in urban sustainability, it is also becoming recognised as a model cities can use to move away from current inequitable resource dependent food systems, reduce their
ecological footprint, and increase their liveability (Dubbeling et al 2010). As indicated in the literature that follows, little is known about the practicalities of running urban agricultural enterprises. In particular, little is known about the environmental, political and social conditions that contribute to the development and sustainability of commercial urban farm projects in cities, and their potential as a tool to address local food insecurity. This research in part addresses this gap by exploring the stakeholder experiences of two community-based urban aquaponics enterprises, with the aim to contribute towards an understanding of how cities can devise robust food supply systems for their growing populations. In doing so I answer my key research question: ‘What are the elements required to foster the development of urban aquaponic social enterprise?’

Aquaponics is the combined cultivation of plants (hydroponics) and fish (aquaculture) in closed recirculating systems (Bernstein 2011, Diver 2006, Wicoff 2011). In an era of growing food insecurity and diminishing natural resources, it presents as a promising sustainable food producing technology that is easily adapted to urban environments (LeBlond 2012, Bernstein 2011). However, the feasibility of an aquaponics system is very site-specific (Rakocy 2006), and, though the scientific literature around aquaponics has matured, it is still scarce. More research is needed into how systems have been constructed and maintained in different social and environmental settings. Evaluating the sustainability of a community focused aquaponics enterprise presents even more challenges because of the varying definitions of sustainability used in social enterprise models. Consequently, this research will not be a technical study of aquaponics per se; rather, it aims to analyse the ‘socio-technical’ conditions needed to foster the sustainability of community urban aquaponics enterprises, and to examine the strategies that are being implemented to achieve this.

The two enterprises are based in the relatively affluent cities of Melbourne, Australia and Milwaukee, USA, and are loosely representative of the transformative, D-I-Y (Do-It-Yourself), counter-cultural
community in each city. However, as I argue, aspects of my findings could serve to help with the planning and design of similar urban farming enterprises around the globe, including in cities in the Global South. I explore the nature of socially oriented urban aquaponics enterprises through qualitative interviews and discourse analysis, using themes developed through the literature review. My findings indicate that in spite of the technical, legal and social difficulties in setting up such enterprises, urban aquaponics has considerable potential as an option for providing a more socially equitable and environmentally sustainable food production alternative for cities.

This thesis is structured as follows. In the literature review, I examine recent findings on the key thematic areas of the thesis: urban agriculture and aquaponics, food insecurity, government policy, sustainable development and social enterprises. In addition to identifying the specific gap that this thesis addresses, the review also develops a conceptual framework for the empirical work that follows. The diversity of themes identified in the literature lead me to structure my investigation using a comparative case study methodology, comparing the two cases of Milwaukee and Melbourne. I also employ mixed methods, to test for the presence of known and unknown factors. In each study I conduct in-depth interviews with key stakeholders, and survey general stakeholders, so as to best explore their relative contexts, objectives, and structure. Based on these findings, I highlight the challenges and suggest relevant indicators for consideration when establishing successful urban aquaponics enterprise.

Ultimately, the creation of “food secure” cities depends on the developing food systems that are right for individual cities. By drawing on the experience and knowledge of community groups through research, and through the sharing of practical experience of community-focused urban food enterprises and the role they can play a part in addressing both urban and global environmental crises, food security may become less of an aspiration and more of a reality. As cities grow and become increasingly vulnerable to the threat of food insecurity, citizens have become more aware of the shortfalls of the current food
system and its inability to provide a holistic and equitable response to these threats. More needs to be known about how to build and sustain better food systems. By documenting, comparing and analysing the experience of two urban aquaponics social enterprises and their strategies for sustainability, the current study aims to contribute to this need, and ultimately, to the fostering of more food-secure cities.
LITERATURE ANALYSIS

I begin the literature analysis with a general review of literature of urban growth and the threats to sustainability faced by cities today. From here I move to literature surrounding the food insecurity of contemporary cities, and the significance of urban agriculture and its contribution to sustainable urban development. I highlight examples that demonstrate the challenges of producing food in the urban environment and how this impact is strongly linked to political awareness and hence policy. Looking to the organisational nature of my research cases, I then introduce ‘social enterprise’ and map discussion on the motivating forces behind its recent emergence, its potential to redefine the concept of wealth creation and how it aligns with the theoretical framework of sustainable development. I also touch on the challenges faced by social enterprise in defining a working model that properly addresses all its objectives and business needs and how this in turn affects its sustainability. Finally I introduce aquaponics and consider its potential as an environmentally friendly food producing technology, in turn reflecting on available literature regarding its relative youth, specific needs and vulnerabilities.

In the review I cover conceptual themes relevant to building a social enterprise using aquaponics technology yet unproven at a commercial scale, in an environment not traditionally associated with food production. In doing so I highlight the gaps in literature related to urban aquaponics. Overall, the comparative study of the two enterprises identified in this research serves to strengthen knowledge and development of methods to address the challenges of urban food insecurity.
Food Insecurity and Urban Agriculture

As cities grow, they demand greater supplies of food and place increased stress on surrounding ecology, through urban by-products of sprawl, pollution, emissions and waste (UN-HABITAT 2004, FAO 2009). Globally, many authors have argued urban populations are facing food insecurity threats as a result of increasingly centralised food distribution systems, growing fuel prices and urban sprawl affecting urban food security and overall economic and social resilience (Koc et al 1999, Addy & Pike 2009, Viljoen & Wiskerke 2012, Allen & Wilson 2012, Ackerman Leist 2013). This is especially so in the Global South, as large numbers of economic migrants and refugees flood into cities (UN HABITAT 2004), while in the Global North urban ‘food deserts’ are also becoming increasingly common (Allen & Wilson 2012, Addy & Pike 2009, Ackerman Leist 2013). Almost completely dependent on produce imported from other regions, urban consumers are particularly vulnerable to food insecurity. For those of low socioeconomic status, this dependence means that any fluctuation in food prices or income is translated into limited purchasing power, increased food insecurity and compromised dietary options (FAO 2009).

In 1999 researcher Luc J A Mougeot from the International Development Research Centre (IDRC) defined Urban Agriculture as:

an industry located within (intra-urban) or on the fringe (peri-urban) of a town, a city or a metropolis, which grows and raises, processes and distributes a diversity of foods and non-food products, (re-)using largely human and material resources, products and services found in and around that urban area, and in turn supplying human and material resources, products and services largely to that urban area (Mougeot, 1999).

Stuck in the challenging cycle of limited earnings versus high living costs, and coupled with decreased employment opportunities, urban agriculture (UA) has been increasingly viewed as a way to manage
their situation (Dubbeling, de Zeeuw & van Veenhuizen 2010). Recent literature indicates that residents of cities in both the Global North and South engage in UA for social, ecological and economic reasons (Mougeot 2005, Dubbeling et al 2010, UNDP 1996). Often employed as a tool for building social capital and for facilitating education about healthy living and the natural environment, UA has also proved to be effective in beautifying cityscapes and improving neighborhood safety (Koc et al 1999, Pearson et al 2010, Allen 2012, Viljoen & Wiskerke 2012). For people who might otherwise spend a large portion of their income on food, UA can provide anything from a simple increase in fresh food intake and small income supplement to full time employment (Dubbeling et al 2010, Allen 2012). However, access to fresh food is becoming increasingly difficult on account of limited availability of arable land, pollution and extreme weather patterns (FAO 2009). Hill and Mustafa (2011) argue that in order to move towards more sustainable development, communities need to consider how these UA enterprises contribute to meeting basic needs such as food, health and energy security and ‘how these are balanced with policies to promote quality of life’. My study directly addresses this ‘how’ question in relation to the specific area of urban aquaponics.

Urban Agriculture and Government Policy

Despite not having a recognised institutional home in most urban governmental or policy frameworks (Gooley & Gavine 2002), UA activities and enterprises are deeply affected by government policy. While some cities actively support urban agriculture through funding, land donations or protective zoning, other local policies can also present barriers to urban agriculture. Often these barriers are unintentional. Several studies have highlighted the need for more research into how reconciliation between urban producers and government has been reached, along with where and when it has taken place (Murkherji
& Morales 2010, Dubbeling, de Zeeuw and van Veenhuizen 2010). In part motivated by this suggestion, my research has been designed to allow for the identification of obvious indicators based on the comparison of two similar projects in different policy settings.

The American Planning Association (APA) and the Food and Agricultural Organisation of the United Nations (FAO) suggest that municipalities should do more to encourage UA because of its potential to create jobs, provide capacity building opportunities, foster community development, diversify urban food sources, increase community resilience and introduce new regions of urban green space (Murkherji & Morales 2010, FAO 2009). They argue that the reassessment of zoning designations by municipalities can foster UA by creating land use ‘categories’ for activities that might previously not have been considered viable in an urban environment (Murkherji & Morales 2010, EPA 2012). In 2011 the US Environmental Protection Agency (EPA) reviewed urban zoning codes in US cities, conducting interviews with key stakeholders with the intent of making recommendations to urban municipal governments on how local laws might be adjusted to permit growth of UA (EPA 2012). Milwaukee, a city where one of the case studies is located, was specifically recommended to adopt a policy of re-categorisation of zoning codes to promote UA by lifting restrictions related to certain types of animal husbandry and bee keeping (EPA 2012). More generally, Pearson, Pearson and Pearson (2010) draw attention to the need for research into governance policy and practices that identify innovative institutional frameworks for success as a way to bridge these institutional ‘knowledge gaps’.

Over the last decade the FAO and UNHABITAT have prioritized food security on their action agendas. This recognizes the role UA has in the fight against urban food insecurity (Hill & Mustafa 2011). Metcalf and Widener (2011) suggest that to improve ‘effective food policy support tools’, a closer examination in different settings needs to be made of decision-making processes amongst stakeholders ‘with widely varying perspective on the problem’. There appears, however, to be little research that directly
compares and analyses UA policy drivers, agendas and objectives and perspectives between comparatively and contextually similar UA practices. This gap in part motivates the current study.

International agri-food and trade policy also plays a significant role in the viability of the type of small-medium scale agricultural enterprise that is common to the urban setting (Whittman 2011, Lee 2012, Thibert & Badami 2011). The WTO, for instance, has argued that international trade has ‘reduced the price of food over the years through greater competition and enhanced consumer purchasing power’ (WTO 2011). Highlighting a problem faced by most small farmers when looking to compete in the market, Thibert & Badami (2011) argue that today’s price of food is a poor reflection of its real ‘embodied’ social and environmental costs from ‘farm to fork’. They further contend that most consumers are unaware of the subsidies, environmental damage and ineffective regulation involved in food production, and suggest that policies need also to be directed towards consumer education about UA or the demand-side of the equation.

The FAO (2003) suggests an increasingly centralised food market is unlikely to benefit all sectors of society and that negative impacts ‘will be seen on small scale commercial farmers, rural and non-rural farm producers urban consumers both within and across countries’. Michael and Schneider (2011) further argue that if state authorities were to support small farmers though political action – by, for example, redirecting subsidies to smallholding communities – this would alleviate the pressure on urban hubs, decrease land degradation by moving away from synthetic fertilizers and industrial farming techniques, and overall, serve to ‘revitalise the myriad of local and national food markets’. With this in mind the questions I posed to stakeholders seek to uncover the perceived impact both national and local government policy had on each case.
Sustainable Development and Social Enterprise

Designs to remedy social inequity and environmental degradation are frequently framed within the theoretical context of sustainable development. To varying degrees, sustainable development rests on the interdependent creation and balance between social, economic and environmental priorities from the local to the global scale, both currently and in the future (Davies 2008, Femia et al 2001, Connelly 2007). As an example, Goerner, Lietaer and Ulanowicz (2009) argue that in evaluating economic sustainability, traditional economic theory fails to distinguish healthy development from mere growth in GDP and monetary volume. They claim that in order to be sustainable, economic development must invest in environmentally sustainable, community capital because it increases social vitality and resilience. They further contend that sustainable development’s triple Bottom Line combination of community development, small scale economies development, and Green Jobs/infrastructure development tend to produce more socially, economically and environmentally sustainable wholes (Goerner, Lietaer & Ulanowicz 2009 p 80).

With this in mind, the analysis of just the sustainability of economic, environmental or social elements of any project should not be made without the consideration and reflection on the other two (Davies 2008). UA initiatives that formally contribute to environmentally sustainable, social economic development fall under the banner of ‘social enterprise’ (SE) (Connelly 2011). SEs, as distinct from private enterprises, aim to create new business models for the provision of products and services that cater directly to basic human needs that remain unsatisfied by current economic or social institutions (Seelos & Mair 2005, Davies 2008). In 2003, the World Bank stated that mainstream services meant to satisfy basic human needs, particularly those that contribute to health, food and education, are failing poor people in terms
of access, quality and affordability (World Bank 2003). For alternative service models such as SEs, the primary motivation is not maximizing profit but meeting social needs and building social capital. They do this by using their business to address a range of services from education and training, to housing and environmental protection. Potentially, they therefore, offer alternative mechanism for delivering products and services to those who cannot afford them through traditional markets.

As suggested in the preceding section, SEs do not operate in a political or economic vacuum. External conditions such as government policy, conditional funding and relationships with local authorities and other stakeholders are likely to influence their activities, as are pressures to compete with an private sector that is increasingly marketing itself as ‘sustainable’ (Darby & Jenkins 2006). These pressures can be compounded by common internal factors such as unclear organizational structures, irregular staffing levels and conflicting priorities (Davies 2008, Darby & Jenkins 2006). Seelos and Mair (2005) suggest that the study of the interfaces between SE and public institutions offer great potential for discovering new forms of collaborative value creation in support of sustainable development. They argue moreover that more research is needed to more accurately define how the public sector can best collaborate and support SE, given the variety of challenges involved in achieving sustainable development goals. This research aims to fill this gap in relation to the specific activities of urban aquaponics social enterprises.

**Defining ‘Sustainability’ in the Context of Social Enterprise**

Through their creative ability to draw on alternative resources and combine them in new ways, SEs are a rich field for the discovery of inspired models of value creation, and for this reason the evaluations of success in the social economy requires attention to benefits beyond conventional model of economic efficiency (Seelos & Mair 2005). In traditional entrepreneurship the creation of social wealth is a by-
product of economic value created by entrepreneurs [Darby & Jenkins 2006]. In contrast, for SEs, social value creation appears to be the primary objective, while economic value creation is instead a by-product that allows the organisation to achieve sustainability and self-sufficiency. The concept of SE aims therefore to challenge conventional thinking about the purpose of an ‘enterprise’, along with what is feasible and what constitutes sustainable growth (Seelos & Mair 2005, Goerner et al 2009).

There has been considerable discussion over what constitutes economical sustainability in the case of SE (Chell 2007, Darby & Jenkins 2006). SEs are often established on philanthropic donations, seed funding or government grants secured through their promise of beneficial social or environmental outcomes. Many continue in this form of grant dependency, preferring to focus their energies on social rather than financial outcomes. Other SEs attempt to blend social benefits and commercial activities. Another model involves SEs working towards and achieve complete financial independence. Chell (2007) claims that all three models can be recognised as economically sustainable forms of SE.

The conflicting priorities faced by social enterprise attempting to reconcile traditional business models and objectives with social and environmentally ethical objectives can be very challenging (Chell 2007). There appear to be few examples that examine how social enterprises determine the appropriate ‘mix’ of social and economic priorities; how these priorities have been reconciled amongst stakeholders; and how they are justified to the public (Darby & Jenkins 2006).

**Urban Agriculture in Practice: The Case of Aquaponics**

The last 30 years has seen UA come to involve an ever-widening range of production systems, technical solutions, actors and policy instruments to facilitate growth of the more sustainable, healthy, food secure cities (Mougeot 2006). A recent development is the field of aquaponics, a largely unexplored but
increasingly investigated hybrid system that links recirculating aquaculture (fish farming) and hydroponics (growing plants in water without soil) (Rakocy 2010). This system has several advantages: fish waste is absorbed by plants as food; plants can purify the systems water; and together both processes eliminate the need for expensive bio-filters, fertilizers and contaminated waste water disposal and recharge. It is also more productive and less energy intensive when compared with traditional agriculture production (Bernstein 2011).

Current aquaponic technology ranges from backyard hobbyist to technologically scattered private commercial systems with unclear success rates. A single source for protein (fish) and nutrients/vitamins (vegetables), the development of a technologically simplified commercial scale system seems to offer genuine potential for many impoverished and malnourished communities to address issues of food security (Wicoff 2011). Despite this, relatively little research has focused on efforts to translate this theoretical potential into practice. As several authors argue, more study on the financial (Wicoff 2010, Goodman 2011) and technical feasibility of real-world aquaponics systems (Rakocy 2010) is needed.

In 2011 Goodman conducted research into the financial viability of an urban aquaponics social enterprise in the city of Milwaukee, the same city as my case study subject, Sweet Water Organics. It was found that growing yellow perch and vegetables using the Growing Power system model was 'insufficient' to balance operating costs as a stand-alone for-profit business, but that this outcome could be moderated by changing the size, business model or through having diversified income streams (Goodman 2011). Interestingly, the author stated that if the system was not efficient enough to be profitable – even though based on its history it had proven a beneficial tool for community development and education – thought should be given if community and economic development benefits of the system are enough to justify the costs (Goodman 2011).
Although there is very little research literature related to commercial urban aquaponics, certain factors are equally if not more relevant to market aquaponics systems in the urban environment, where rent and market competition generally significantly higher. Drawing, in part, on the 30 years of research of James Rakocy (2003), there are a series of questions that are relevant to establishing for any aquaponics enterprise from a technical point of view:

- What are the environmental conditions of where the system is built – do energy dependent heating or cooling devices need to be used on account of extreme weather conditions?
- Is there enough sunlight or do you need artificial lights?
- Are the electrical, construction, labour, water and land/rent costs low enough and the system big enough to make the venture viable?
- What are the fish processing costs and requirements?

With the broader themes of sustainable development, food security and social enterprise developed above, I have used a further series of contextual questions to guide the methodology I develop below. I also argue that these technical questions need supplementary criteria that consider the socio-economic context. No such criteria are currently available in the academic literature on aquaponics. The purpose of the current research is to address that gap.

As the sparse literature suggests, there is potential for aquaponics to be used as an environmentally friendly tool for urban community focused food production. However, the gap in existing literature points to the need for research into what social, political and environmental factors might affect the ongoing economic sustainability of community driven urban aquaponics enterprises. My research addresses this shortfall of knowledge, conducting a comparative case study of two community urban aquaponics enterprises in two distinct but comparable settings.
In this section I outline the rationale for research approach I adopt and the selection of the specific cases in more detail. I describe the methods for data collection and analysis I use to contrast the cases. The overall design and structure of the study was driven by the need to enhance the comparative perspective of the study so as to allow for solid findings and a well-grounded analysis. However, I also reflect on the limitations of my research methods, and how these might affect my findings and conclusions.

As the literature review suggests, there are few studies that describe small-scale, community, urban aquaponics enterprises, and in particular, the sorts of conditions that affect their sustainability. I employ a cross-sectional, comparative case study approach to examine these conditions. This approach offers an effective method of research design that allows for the investigation and detailed understanding of a contemporary phenomenon where such understanding is closely aligned to the contextual circumstances of the subject of study (Yin 2009). This is significant since it will be through the analysis of the varied political, environmental and social contexts that distinctions between each case will be drawn, allowing me to triangulate sources and compare results, with the potential for more robust findings (Maxwell 2005).

To fill this gap, I examine two such projects from Melbourne, Australia and Milwaukee, USA. A prerequisite for my case selection was that both projects be community focused (i.e. a community development driven social enterprise), urban and market-oriented. Both cases fit these criteria, though they are considered small-scale production enterprises, young (no more than 5 years old) and to a large extent experimental on account of their pioneering status in the aquaponics field and urban context. In terms of size, both projects are less than 150m², and have no more than 10 employees or volunteers each. The SWO system is almost twice the size of the CERES system; however, both are at the smaller
scale of non-hobbyist aquaponics operations. It is hard to make an accurate estimate as to overall capacity, as neither were working to capacity during the research. Sections of the SWO system were not productive at all, the reasons for which I will explain in my results analysis. Established urban aquaponics projects of this type are still very rare, and these sites were fortuitously of relatively similar age and context.

Although I have been involved in the urban agricultural movement in my own city of Melbourne, I was unaware of aquaponics until it was brought to my attention through my work as an intern with the UN Global Compact Cities Programme (UNGCCP) in 2011. This position provided me with privileged access to the Milwaukee-based Sweet Water Organics aquaponics enterprise, and strongly encouraged my research in this area. The relationship between the for-profit enterprise and the urban research and sustainability arm of the UN Global Compact came about when SWO formed part of the Milwaukee Water Council UNGCCP Innovating Project in 2009. This successful project was dedicated to the economic development of Milwaukee through the sustainable use and re-use of water – a banner under which aquaponics fits comfortably. Water has a history of strategic importance to Milwaukee, with the city founders and principle industry sectors selecting the site on account of its abundance.

The second case, CERES Aquaponics, was established by members of the Green Technology Team CERES Environment Park in the inner northern suburb of Brunswick, Melbourne. I established contact with CERES aquaponics project director Steve Mushin in late 2011 when I was scoping for this study. In addition to Steve I had regular contact with the expert aquaponics biologist (who wishes to remain unnamed), who had been consulted during its construction and had run the system as his own business for a short interval and continued to provide support. My conversations with the expert, who had many years of experience in aquaponics research and industry, were extremely valuable in terms of giving me a sense of how an
aquaponics system functions as well as the nature and (comparatively short) history of the aquaponics industry.

The similar physical characteristics of the two aquaponics sites, along with their ages and objectives, suggests them as feasible candidates for a comparative case study research project of this depth. Characteristic of small scale social enterprise, both cases have been built and promoted as community education and skill sharing centres, and their energies are strongly focused on these activities. In line with my research objectives of gaining a better understanding of a transition enterprise I explicitly frame my questions to highlight the complicated implications of being representative of a transformative, D-I-Y (Do-It-Yourself), counter-cultural ideology. These features for comparison permit me to make develop more grounded insights on more favourable or unfavourable combinations of factors that could be used to increase the effectiveness and sustainability of similar projects in the future.

Despite the broad similarities mentioned, upon closer examination these two cases feature marked differences, most noticeably in terms of their internal administration and urban political environment and the perceived food security status of their cities. Consequently, I employ mixed methods within a broader exploratory case study framework (Yin 2009) so as to allow for in depth analysis and understanding of both known and unknown factors. This appeared to be the most appropriate approach for making an assessment as to the sustainability of social enterprise in a relatively new industry and in an environment that is not traditionally associated with food production.

Maxwell (2005) and Yin (2009) argue that qualitative research in any ‘multiple site study’ needs a clearer pre-structuring than most single case studies. Despite this I was realistically flexible about the necessary timing of my research activities, so as to accommodate for the inevitable challenges that arose from trying to ‘pin down’ busy key stakeholders from either side of the globe. To ensure this need for
flexibility did not confuse my desire for comparability I wrote up a plan to guide my research. My data collection process was greatly facilitated by being able to visit the Milwaukee site in September 2012.

**Data Collection**

My data collection methods included informal observation and site visits as well as a stakeholder analysis and media review. I also employed online surveys which I sent to primary stakeholders and conducted semi-structured interviews with at least two key informants in each case. Ethics clearance was granted for this study in June 2012.

As a preliminary base-line activity I undertook a stakeholder analysis that considered the conditions, processes and objectives driving each case and explored how this context affects and was affected by stakeholders (Freeman 2004). To form a clear picture of each organisation and the industry I had chosen to examine I conducted a comprehensive analysis of contemporary media produced by the organisations (i.e. website and promotional material), and by other academic and media sources. I reviewed local government websites and policy documents in relation to urban agriculture, social enterprise and food security. I also spoke informally with project leaders involved in both organisations, to gain a sense of who the key internal and external stakeholders might be. From these responses, as well as media sources, I drafted a list of stakeholders I might interview to gain different perspectives on the ‘sustainability’ of each enterprise.

Further activities included a background analysis of the sites for the purpose of defining factors like respective weather conditions, existing markets for produce, utility requirements, inputs and produce outputs, costs and the perceived food security status of their immediate environment and cities as a whole. I looked at the varieties of fish and vegetables produced and consider how they might impact on
economic viability. In addition to the stakeholder assessment I conducted a broader analysis of existing policy documents and council planning and zoning regulations related to these projects. These documents were sourced through local municipal offices relative to each case.

My main data was sourced from a combination of online questionnaires, distributed online, and more intensive interviews with the stakeholders identified through my work with the UNGCCP in combination with the preliminary analysis described above. The short answer and multiple-choice online questionnaire was designed through the survey tool, Jotform. This I distributed by email to the broader group of internal stakeholders that had been identified in the initial stakeholder analysis and discussions with project leaders.

The survey questions (see Appendix 1) were divided into different sections that were guided by significant themes identified in the literature. It started with several questions about the person’s role and history with the project; I then asked about their understanding of the objectives of the projects and whether they thought there was consensus amongst all stakeholders as to the objectives of the project. This was to test for issues in the reconciliation of priorities often face by people trying to run a business directed by social and environmental prerogatives. The next sections asked about the level of community support and engagement in the project, and their priorities in what constitutes sustainability. I then provided a multiple choice section on perceived challenges and achievements with a section provided where survey participants could add or elaborate on the information that had provided. I finished by asking what the respondents thought was needed to establish a sustained and growing urban aquaponics industry in the future.

The data generated from this survey allowed me to confirm the themes by which the data was eventually analysed; it also helped me to refine a line of inquiry for subsequent oral interviews and steer the appropriate selection of key informants for these interviews. The fact that these surveys were conducted
with a larger sample of participants identified through the stakeholder analysis and site visits meant I could to some extent avert the risk of 'key informant bias' (Maxwell 2005 p. 91). Their insights were also essential for addressing the question of authenticity, credibility, representativeness and meaning with regards to how key informants are selected, and the quality of the data produced from interviews with such a small number of participants (Bryman & Burgess 1999).

Following the survey I conducted unstructured qualitative interviews with project stakeholders to ask specific questions about each case and clarify any discrepancies I had noticed in the survey data. We covered the history and future plans of the enterprise, as well as the challenges interviewees had encountered along the way. In all the interviews I was aware of the relationship or role each interviewee had with the enterprise and directed my questions accordingly to add to the depth of perspective on the project and my analysis. At SWO, I interviewed several key stakeholders who were present on the day of my visit; respondents included the founder, the Milwaukee City Director, a volunteer and board member, and the Sweet Water Foundation education and outreach program coordinator. At CERES I interviewed the founder and the assisting aquaponics expert. These data were further supplemented with analysis of project documentation and observations made through site visits. Unstructured interviews were considered suitable due to the range of roles and experiences of key informants, and because I wanted to allow for unpredicted events or findings (Bryman 1999, Yin 2009). The interviews were kept within a time limit of one hour and questions varied according to the role and expertise and context of the stakeholder.
Prompted by the technical questions outlined in the literature review questions and the limited amount of trialled technical information and expertise in the aquaponics industry, I was led to consider whether the following practical questions might also be relevant:

- Who designed the system?
- Who built the system?
- Has it been trialled before at a commercial scale?
- Will you need ongoing support to maintain it?
- Is this support readily available?

While I did use the interviews to inquire into basic costs and iterative feasibility I did not request specific financial reports as I was not conducting a financial audit and summary of each case. A ‘cash flow analysis’ of the Growing Power aquaponics model has already been done as a part of Master thesis in 2011; that research concluded that there were insufficient sources of revenue for this aquaponics system to offset regular costs when grown in small quantities and when operated as a stand-alone for-profit business (Abstract, Goodman 2011).

My research was focused more on the broader contextual and organisational elements that appear to affect the economic sustainability of each aquaponics enterprise.

In addition to the internal functioning and structure of each project, I used the interviews to get a better idea about the relationships each organisation has with its respective local government, customers and its perceived place within the broader food system of the city. Where relevant, the data produced from the interviews were analysed against the data and themes identified in the stakeholder surveys, serving to highlight any contradicting viewpoints or misunderstandings that could be used to explain any setbacks in
the organisational efficiency and economic sustainability of the enterprise. A key dimension of the research question with respect to these two cases is how the stakeholders themselves understand the concept of 'sustainability' – is it for example profitability alone, or is it tied to broader communal and ecological notions of sustainability? The interviews, along with organisational documents and financial records, allowed me to relate the specific operational activities of the projects to different forms of sustainability – economic, social, environmental as well as organisational.

I was able to travel to both sites at least once. Although I was only at SWO for a number of hours this opportunity alleviated my earlier preoccupation of not being able to know both projects ‘in person’. The face-to-face contact with participants also removed most of my anticipated issues associated with coordinating interviews with busy people on the other side of the world.

**Analysis of Data**

The analysis of data was based on the idea of ongoing ‘feedback loop’ of iterative analysis and concept development (Yin 2009). Bryman and Burgess (1999, p.21) urge the researcher to be aware that the data available for analysis are only as good as the data that are recorded. As such the choice of a multiple case study analysis was further justified by potential limitations associated with such a small sample base. The data generated by each case was analysed according to the technique of cross case synthesis (Yin 2009, p.156) where each case is initially researched and evaluated independently of each other and finally compared. This means that while similarities identified each case as eligible for this study it is their difference in decisions they make around their aquaponics system and organisation, as well as their external context and environment – and the impact that these elements have had on their development - that ultimately give basis to my comparative analysis.
The knowledge I had gained from my literature review had distinguished recurring themes that form the basis of my analysis framework. This can be seen most obviously in how the headings in the qualitative findings section mirror the headings in the literature review. In addition to the key themes identified in the literature my analysis was influenced by informal interactions and observations of the case subjects and sites, as well as my own previous experience and ongoing appreciation for urban agriculture.

Limitations

The multiple-case research design was replicated as closely as possible in each case study though the overall design was necessarily flexible in anticipation of any unpredicted outcomes or findings (Yin 2009). Pragmatic factors that affected direct replication included the number and degree of access to key participants in each case; the availability and accessibility of material data (plans, research documents and press materials); and the practicalities of direct observation. In addition, external factors such as distinct climate, economic markets and external government policy make for markedly different conditions.

Survey distribution and responses in both cases also presented some small challenges. In the case of SWO I was only forwarded the contact details of those currently involved in the project and all attempts to secure those of previous employees were unsuccessful. In the case of CERES the number of people involved in the project was so small that two out of the three survey participants were the same people I interviewed. Surprisingly some of their feedback contradicted itself – however, I believe that this had more to do with my poor wording of questions than any real point of significance. For example, when I asked if ‘restrictive government policy’ had posed a challenge to the growth and sustainability of the aquaponics enterprise, no CERES respondent ‘ticked’ that box. Conversely, when I asked two of the same
people in the interviews about challenges in building a sustainable urban aquaponics system, both replied that the effects of government policy make it hard to compete in the Australian food market when operating at this scale.

In spite of these limitations, the selection of two sites and a mixed methods approach to data collection ensures that enough conclusive evidence was generated to identify what factors might affect the sustainability of community, urban aquaponics enterprises.
RESULTS

Introduction

My findings and analysis are laid out as follows: I start with a brief introduction to the results and the process by which they were gathered. I provide an in-depth description of both my cases studies and their history to date. I then walk the reader through the quantitative results I gathered as part of the survey and the tables that demonstrate their relative comparison. I follow this section with a more detailed analysis of the qualitative findings I gathered through informal conversation, sites visits and most of all, the in depth interviews with key informants. This section is presented under thematic headings, with respondents observations’ interspersed. I conclude by presenting a comparative checklist of elements that appear to influence the sustainability of these urban aquaponics social enterprises.
Milwaukee is the largest city in state of Wisconsin, USA. It has a population of approximately 700,000 people; a population which was, until recently, in decline on account of limited employment opportunities as a result of a broader decline in manufacturing in the region (Alder, Lagakos & Ohanian 2013). Situated on the south western shore of the Lake Michigan, Milwaukee has never suffered from lack of water. The Great Lakes region, as it is known, is home to one third of the worlds’ fresh water. With a
significant portion of the population un- or under-employed, and with large areas of the city lacking access to fresh food (Martinez 2011), food insecurity is, however, a reality that many people face on a daily basis. Over the past few years Milwaukee has had a growing ‘foodie culture’ through the increased awareness of, and enthusiasm for locally grown fresh produce. This, coupled with the increased availability and affordability of city real estate since 2008, has provided an ideal crucible for an urban aquaponics project to be tested.

SWO is an urban aquaponics farm, school and experiment that was set up in a large, unused, inner city, industrial building in the Bay View area of Milwaukee in 2008. The brainchild of James Godsil and Josh Fraundorf, it was funded primarily by its founders who were motivated to develop creative capacity building and employment opportunities in their city, while providing, chemical free, fresh, accessibly priced food to the community. Proudly experimental in their approach, SWO provides a living example of alternative uses for urban space and its capacity to produce fresh food. Quoting a SWO founder, there have been a number of ‘iterations’ following the initial business and aquaponics system design, with some noteworthy examples of challenges and adaptations as they work towards achieving economic viability.

Sweet Water Foundation (SWF) was formed from SWO in 2010 with the idea that they would grow as a mutually supportive, cohesive hybrid organisation that was both a for-profit (FP) commercial urban farm and a not-for-profit (NFP) aquaponics ‘academy’. Local community and schools were engaged from the ‘get go’, and as financial resources were raised SWF started using aquaponics to teach people of all ages to grow food. In its own words, SWF addresses issues such as

- community and economic development,
- health/wellness concerns,
- the STEM disciplines (science, technology, engineering, and mathematics),
- and environmental awareness and stewardship (SWF website 2013).
SWF has since worked with approximately 100 schools in Milwaukee or Chicago. In 2011 it won US$175,000 to develop a ‘badge’-based aquaponics online digital training and credentialing platform, which is due to be launched in 2013.

Much experience and inspiration for SW members originated from Will Allen’s urban farm ‘Growing Power’ (GP), although there was minimal formal research done in preparation for the venture. As a founder put it, ‘we were artisans and social enterprisers (sic) who knew how little we knew’. Their first aquaponics system was based on the GP three-tiered model as of 2005. Within a year, however, both founders realised the GP system was inadequate for commercial scale aquaponics, and its inefficiencies were made worse by its installation in a large dark warehouse. A number of costly adaptations were made, however, they could not get around the debilitating energy costs of having to use artificial lights in the grow beds and the need to pump large amounts of water 24/7. A lot was learned in this process. Fish-to-plant ratios were refined, a new filtration system designed and, as the business was still working at a loss after 3 years, stakeholders had many ‘critical, strategic, reflective moments’.

There has been considerable support given to SWO and UA by the Milwaukee municipal government (EPA 2012). In 2011 SWO requested a loan from the city for US$250,000 to help pay the wages of its employees, and to upgrade the system to a more energy efficient outdoor model. A forgivable loan was granted, with conditions that a certain number be created annually over the next few years, and the new system was installed by Aquaponics UK in 2012. The circumstances surrounding the grant meant that SWO, the integrity of its founders and the validity loan was scrutinised by the local media (Daykin 2012). Interestingly, there was no question of how realistic the conditions were for meeting job creation targets of 45 jobs by 2014. In hindsight, these expectations were unrealistic, using a system incapable of supporting that many people (even if operating to capacity), and in the context of a national economy that continues to struggle.
The SWO farm needed to achieve profitability before the end of 2013. Recognising the need to diversify their income streams, all current economic projections are based upon the cultivation and sale of ‘sprouts’, independent of the new aquaponics system. There were projections for the new system, however, these are considered less reliable because aquaponics, at a commercial scale, is still viewed as an ‘untested production technology’.

The SW ‘not-for-profit – for-profit’ hybrid enterprise model is both new and challenging, with each half struggling to identify what their role is in the other. Each organisation has a different governing structure and sources of funding; and although their operations have constantly overlapped, their strategic planning and visions have sometimes not. Critical to the sustainability of this relationship has been the sharing of board members who have been essential in keeping up ‘communication and awareness’ on both sides.

The experimental nature of SWO and its delayed financial independence has meant that volunteer and paid workers have often worn a number of different hats depending on their ability and availability. While this form of decision-making has allowed SW to remain fluid and flexible, it has sometimes presented challenges when personal situations change or skill requirements evolve. In October 2012 SWO had 11-13 permanent employees, and was still being sustained through loans financing and equity investment. Meanwhile, SWF had two paid employees and a number of full time volunteers with at least five volunteers working at SW on any one day. By June 2013, as loan repayments fell due and the ambitious production targets were not met, the ‘for-profit’ arm was effectively in liquidation and the farm was shut down. Where possible SWF negotiated the absorption of most of the SWO however the operational and ownership status of the new system is still unclear.
Melbourne is the capital city of the southern state of Victoria, Australia. It has a population of four million inhabitants and a cool temperate climate. A steadily growing population has seen property prices increase dramatically over the last 10 years, with most activity around urban infill and peri-urban greenfill growth (ABS 2013). The city comprises of a multinational population, and although pockets of food insecure areas have been identified in parts of the city (Addy &Pike 2009), food security is not a high priority in local or state politics.

CERES is a community environment park and centre for education and research in environmental strategies. It is a well-known eco/sustainability hub in inner city Melbourne, and, according to the CERES
website, has over 100 mainly part-time employees and 400 or so volunteers (CERES website 2012). More than 300,000 people visit CERES each year, and even more engage through their Sustainable Schools program. CERES is an incorporated not-for-profit organisation which operates a number of FP enterprises to support its NFP ventures. Over the last two years CERES has gone through considerable financial and structural readjustment. All projects within CERES are expected to be self-sustaining in an economic sense.

The CERES Aquaponics system was designed and built by the then CERES Green Technology team Manager Steve Mushin. He had been ‘playing around’ with aquaponics for five to six years and had a close working relationship with the aquaponics expert who had worked as a volunteer at CERES. Viewing aquaponics as a way to mitigate community food insecurity, the objective was to build an aquaponics system that had low building and maintenance cost, but which would be capable of producing at a commercial rate so as to employ a single full-time employee. It was built using a AU$100,000+ grant over a few months. Being an experimental prototype this is not indicative how much and how long it would take to build other similar systems.

The aquaponics system itself is an 80m\(^2\) floating raft deep bed system, with two repurposed 1000 litre tanks for the fish. The fish tanks sit higher than the plant pools, and are housed in a shipping container that has one side cut out of it so that it opens into the greenhouse. The system at CERES was designed as a ‘sub-optimised commercial system that has low energy use, robust and is easy to use’, with the production capacity to support a single wage. It is still in the process of refinement, however, with the expert still volunteering his time on a regular basis to address problems as they arise.

The employment design model is also still a work in progress, with challenges arising from being able to find an individual with all the skills and patience necessary to maintain an experimental aquaponics system. Both Steve and the expert have run the aquaponics system at different intervals, as did a
horticultural student who eventually got burned out from working multiple paid jobs so she could afford to work on the system. A new farmer has recently been found.

Although still not working to capacity, the system is completely self-sufficient in energy and water and produces enough produce to support the farmer who maintains it. The farmer’s income wage depends on how much he produces with all produce being sold directly to the CERES Fair Food organic box delivery enterprise in the neighbouring building.

Survey Results

The preceding sections cover the background of the projects; here I discuss survey results posed to project stakeholders. Below are the tabled and summarised results of the multiple choice and short answer questionnaire that was administered online to people who had been confirmed as being directly involved in the operations in each case. They were identified to me via a broader stakeholder analysis I conducted in each project, with their specific contact details being put forward by key organisational stakeholders once participants had given their permission to be contacted.

Each graph represents the quantitative results of all significant questions administered by the survey. All raw data has been configured to show the relative percentage of answers given so as to allow for comparison. While predominantly multiple-choice, all survey respondents were given the opportunity to add or elaborate on their responses. The distinct number of respondents in each case makes it hard to draw conclusive comparisons, and the particularly small number of respondents in the CERES case means the quantitative data is limited. The additional comments made by participants enhance the depth of the data collected, and provided insights for the line of questions pursued in the subsequent in-depth interviews.
Due to the small size of each project, survey sample sizes are small. The CERES sample size was three, while the SWO sample size is nine. Many survey respondents participated in the in-depth interviews that followed.

**Clarity of Objectives**

The survey participants were asked ‘How clear to you are the key objectives of CERES Aquaponics/Sweet Water Organics?’ This, and the following two questions pursue the point made by Davies (2008) in the literature review, that social enterprises are often compromised by lack of clarity of objectives. As Figure 3 shows, more than half of the respondents in each case felt either ‘rather clear’ or ‘very clear’ about the key objectives of their project. The remaining responses indicate that close to one third of people felt rather unclear about the objectives of the CERES and SWO project.

![Figure 3](image-url)

**FIGURE 3** – How clear to you are the key objectives of CERES Aquaponics/Sweet Water Organics?
Understanding of Objectives

Figure 4 shows answers to the question ‘In your understanding, what are they key objectives of CERES Aquaponics/Sweet Water Organics?’ Results show that, true to the nature of social enterprise, participants aspire to contribute to the development of a more food secure sustainable urban environment that builds employment opportunities and provides a platform for continued research in applied aquaponics.

The additional objectives serve to clarify and expand upon the objectives offered in the multiple choice list. Most notably, in both cases people identify creating a model that serves to demonstrate the ‘financial viability’ of urban agriculture using aquaponics as an objective. The list displays the more expansive objectives of SWO, when compared with CERES. These objectives appear to be closely aligned with the actual work of SWF, as one respondent points out: ‘I believe SWO (the business) also has an objective of becoming profitable, while the objectives listed above are those of the Sweet Water Foundation’.

The following additional objectives were identified by a CERES stakeholder:

• To provide a model for intensive urban food production to demonstrate the financial viability of urban farming.

The following additional objectives were identified by SWO stakeholders:

• To provide educational opportunities in the STEAM disciplines. To act as a community hub. To increase environmental and food production awareness. To integrate art and culture into food production.

• To develop a successful sustainable business model.

• Commercialization, Democratization, and Globalization of aquaponics and other applied biotechnologies.
• I believe SWO (the business) also has an objective of becoming profitable, while the objectives listed above are those of the Sweet Water Foundation.

• Creating an economically and environmentally sustainable model for commercial urban aquaponics and urban agriculture.

• To help build shareable infrastructure for food safety worldwide.

• While they often think that their goal is to do the other three as well, it should be clear to anyone that given the relative youth of the organization and this sort of organization, their immediate to medium-term impact in those areas will be limited.

These additional objectives, particularly those expressed by SWO stakeholders, demonstrate considerable altruism, tempered, as the last comment suggests, by a degree of realism and pragmatism. As my further findings show, pragmatism proves to be a particularly important feature in shaping social enterprise objectives.

![Graph showing key objectives of CERES Aquaponics/Sweet Water Organics](image)

**FIGURE 4** – In your understanding, what are they key objectives of CERES Aquaponics/Sweet Water Organics?
Objectives Over Time

Participants were asked, ‘In your opinion, have these objectives changed over time?’ As shown by Figure 5, in both cases the majority of respondents did feel that the objectives of the projects had changed over time. Listed below, the reasons for the change according to a number of the respondents give an impression of the experimental attitude of the projects. Adjustments for economic reasons and pressures are listed in both cases, while SWO people also identify the confusion caused by their hybrid business model as a reason for evolving project objectives.

![Figure 5](image-url)

**FIGURE 5** – In your opinion, have these objectives changed over time?

Respondents suggested the following additional reasons for change at CERES:

- Initially, I thought it was about building a demonstration model of aquaponics at a scale. Not sure what triggered the change, but usually it is economics.
Respondents suggested the following additional reasons for change at SWO:

- The experiments while creating the system. It was an organic design in a way, where the idea started with Aquaponics and then moved to education, art, community wealth building.
- Natural evolution of a start-up business in a start-up industry. Trial and error, and appropriate adjustments!
- I think there has been confusion regarding the role of the business and the role of the foundation.
- SWO 1.0 moved away from fish to mostly plants 2.0, then away from indoors, and then away... in their evolving search for a workable blueprint, now 3.0?
- Realities such as; the architecture of the space means high energy usage, or the cheapness of competing "conventional" food who are subsidized by all of us - environmental costs are considered "externalities" absorbed by the general populace, etc...To clarify my answer in the next question; as with all such endeavours that rely on consensus building, it (consensus building), is part of the process and as such, it takes time. Time that investors are often loathe to give.

These additional comments suggest that any change in objectives appeared to have taken place as necessary adjustments made on account of the experimental nature of building a social enterprise in a young industry using a new technology.

Consensus as to What the Key Objectives Are

Figure 6 shows that the majority of participants agree that there is consensus as to the objectives of the CERES Aquaponics project, while one third is unsure. In the case of SWO the majority felt that they were not sure if there was consensus or that in their opinion, there was no consensus amongst those involved in the project.
FIGURE 6 – In your opinion, is there consensus amongst those involved in CERES Aquaponics/Sweet Water Organics as to what they key objectives are?

Broader Community Support

Survey participants were asked, ‘Based on you experience with CERES Aquaponics/ SWO what sectors of the broader community have expressed their support for its development?’ Figure 7 shows what people felt in each case to be origins of support for the projects from within the broader community. Interestingly, the vast majority of SWO respondents felt that they had support from most of the areas identified, with all agreeing on support coming from local government and philanthropic organisations. The least support appears to come from state and national governments. In the case of CERES no support was identified to have come from any sector of the food industry, with respondents unanimous about the support from community sustainability and environment groups. SWO respondents provided some additional clarification about the support they have received – it is noted that one person mentions the financial contribution of the founders of the organisation.
FIGURE 7 – Based on your experience with CERES Aquaponics/Sweet Water Organics what sectors of the broader community have expressed their support for its development?

Respondents suggested the following additional groups had shown support for SWO:

- International governmental, academic, and individuals.
- General public.
- Private investors and philanthropists.
- Mostly private funds of the leadership?
- Clarifying the above; to my knowledge, when I say food industry, I mean supermarkets and restaurants. As for large food producers, I am not aware of any support.
Active Community Engagement

Figure 8 shows responses to the question, ‘Based on your experience what sectors of the broader community have been actively engaged with CERES Aquaponics/SWO?’ The groups that have been directly involved in each case according to the survey respondents. CERES lists no engagement with any level of government or the food industry. An equal percentage of respondents in each case highlight engagement from philanthropic organisations, community development and support groups. Eight out of nine SWO respondents listed the engagement of organisations and schools in the project. SWO respondents added some further comments to their response.

FIGURE 8 – Based on your experience what sectors of the broader community have been actively engaged with CERES Aquaponics/Sweet Water Organics in any way?
Respondents suggested that the following additional groups were engaged with SWO:

- General public. Emerging community of aquaponics practice.
- Enthusiastic individuals for their own reasons.

When comparing the level of support (see Figure 7) and level of engagement (see Figure 8) from the sectors identified in the survey multiple choice, while there appears to be support for both enterprises from all levels of government, it is notable that aside from the Milwaukee local government, this has not translated into active engagement. All other sectors demonstrate a close correlation between enterprise support and active engagement.

**External Issues**

Figure 9 shows the answers to the survey question ‘Which of these external issues have presented challenges for CERES Aquaponics/ SWO?’ The majority of CERES respondents identify limited market opportunities and limited production capacity as external challenges. No CERES respondent highlights weather, lack of community support or restrictive government policy as a challenge. In the case of SWO all respondents list the physical location at a challenge to the operation. Eight out of nine SWO respondents also list limited funding as a challenge. In the additional comments made by SWO respondents two reiterate the challenge of building in a physical location not conducive to growing plants, in this case because of the lack of light.

The external challenges identified suggest that perhaps, with a more planning and research in these areas, some of the technical and market challenges might have been alleviated, or even completely averted. The answers to this, and the following question, help identify areas to probe further in interviews.
and inform the indicator checklist of elements that foster the development of urban aquaponics social enterprise.

FIGURE 9 – Which of these external issues have presented challenges for CERES Aquaponics/ Sweet Water Organics? Tick all the boxes that apply.
Additional external challenges for SWO:

- Lack of solid organizational structure - grandfathered organization dilemma.
- Lack of angel venture capital.
- Sniping from the media.
- Indoors is counterintuitive.
- The most important draw-back is the space - they don't get enough day light.

Internal Issues

Survey participants were also asked, ‘Which of these internal issues have presented challenges for CERES Aquaponics?’ As shown in Figure 10, in both cases a majority if not all respondents listed limited employment capacity as a challenge. In the case of SWO poor organisation, perceived financial mismanagement and the limited availability of aquaponics industry technology and research-based knowledge were highlighted by seven out of nine respondents. Interestingly this was not perceived as an issue by any of the CERES respondents – perhaps reflecting the benefits of having an aquaponics expert involved. The additional comments below from SWO respondents draw attention to the challenge of operating as a for-profit/not-for-profit hybrid as well as specifically reiterate and expand on the issues.
FIGURE 10 – Which of these internal issues have presented challenges for CERES Aquaponics? Tick all boxes that apply.
Respondents identified additional internal challenges for SWO:

- I believe consensus is the main problem, but it will resolve itself in time. As for conditional funding, there is an expectation that they should perform like any other business or employer. This is unrealistic.
- Mix profit/non-profit model.

Some of the internal organisational issues identified as challenging by respondents directly reflect the challenges faced by social enterprises, as highlighted by Chell (2007), Davies (2008) and Darby and Jenkins (2006) in the literature review.

Achievements

Figure 11 summarises answers to the question ‘What do you see as the achievements of CERES Aquaponics/SWO?’ SWO people unanimously agree that aquaponics education and community engagement are one of their achievements. Also high on the list is developing community awareness of sustainable/healthy living, developing educational programs and building local networks and alliances. There was also consensus on community engagement amongst CERES respondents. However, no respondent acknowledged engagement and success in the food industry, solidarity amongst workers or successfully pushing for change in government policy towards urban food production. Perhaps the latter was not a priority since it was not recognised as a challenge (see Figure 9).
FIGURE 11 – What do you see as the achievements of CERES Aquaponics/Sweet Water Aquaponics? Tick all the boxes that apply.
Respondents suggested some additional achievements by SWO:

- So glad that you mentioned having fun.

The achievements identified by both organisations reflect their priority and broad objectives as a social enterprise.

**Summary of Quantitative Findings**

The survey questions were framed so as to test each case for known and unknown factors that might contribute or detract from the sustainability of urban aquaponics social enterprise. As shown in the commentary, the known factors previously identified in the literature review are largely reflected in the survey responses. They include issues caused by unclear organizational structures, conflicting priorities of stakeholders and the physical location of a system. Significant unknown factors were limited production capacity of an unproven system, challenges in developing a new business model and the limited market research and awareness in establishing a farm in an urban environment. Worth highlighting in these issues is the obvious perceived lack of translation of broader government ‘support’ into ‘active engagement’.

This is significant in terms of the difference between recognizing and actively supporting alternative social value creation provided by urban aquaponic social enterprise such as these cases. As Goodman (2011) states, ‘where the system does not prove to ‘profitable’ it is important to consider whether community and economic development benefits of the system are enough to justify the costs’.
Qualitative Results

The following pages are an analysis of all the data accumulated as a part of my research. In particular, it draws upon the information generated in the interviews and sites visits. Although the interviews were largely unstructured so as to allow for the discovery of unpredicted information and responses, they were planned around a set of questions I had elected to use as points to remind me of what I needed to cover and prompts for elaboration (examples of the questions I use are included in Appendix 2). The analysis of the data draws on literature and empirical data to identify themes, points of discussion and arguments that go some way to explaining the challenges to achieving the sustainability as a community focused, urban aquaponics enterprises in Australia and the USA. Accordingly, results are presented under thematic headings, with interview data, quotes and analysis interspersed.

Food Insecurity and Urban Aquaponics
Impact of Broader Social and Urban Context

After nearly five years stakeholders in both projects appeared realistic about prospects of their respective enterprises in the current environment. Yet both projects appeared equally committed to a vision of urban food security and sovereignty, where environmental, economic and social benefits would accrue through locally owned and operated enterprises. Both the founder and designer of the CERES aquaponics installation felt aquaponics would struggle in Australia, where water and energy externalities are effectively part or fully-subsidised. However, they also expressed optimism that the technical challenges they had overcome would yield benefits in developing contexts where water and energy are comparatively expensive relative to the capital and labour requirements of aquaponics. In such
environments, urban aquaponics can deliver small-scale and niche products that also increase food diversity in local diets.

Milwaukee and Melbourne projects differ tremendously in terms of their operating environments. Despite existing in distinct climates, the impact of physical climate is only referred to briefly both in the interview and survey results. Both sets of interviewees, however, do describe at length the importance of the political and socioeconomic context. Milwaukee respondents describe the help they have received from the city of Milwaukee; by comparison, the Melbourne project has received at best lukewarm support. This difference could be explained somewhat by the macro-economic performance of each city and the prevalence of food insecure communities. Since 2008, Australia’s economy has maintained positive if low growth rates, while the US suffered a recession in 2008/09. Milwaukee has also been suffering longer-term economic decline as part of the closure of manufacturing in the region. As noted by one respondent, ‘there are thousands of warehouses like this in Milwaukee’ that could be refitted if this initiative proved successful and replicable. This may explain why Milwaukee has been more prepared to invest in an otherwise speculative social enterprise venture. Also, while SWO survey and interviews demonstrate a consensus on the ‘counter-intuitive’ choice to build a farm indoors with no natural light, the experiment appears to have stimulated considerably greater appetite for new UA business development initiatives, even if this requires the city, as one respondent put it, to ‘interpret the law to support our experiments, to change the law where necessary and to participate with civil society and grassroots organisations’.

According to respondents, socially oriented aquaponics enterprises such as Sweet Water are appealing to the cities like Milwaukee because they offer a solution to the threats of food insecurity and social disintegration. The Mayor of Milwaukee, inspired by the potential of ‘transforming the rust belt and warehouses using UA’, wanted Milwaukee to be ‘trailblazer for UA’. Through decreasing zoning restrictions the City of Milwaukee hopes to increase their revenue base through land tax and at the same
time raise the city’s profile and make local UA enterprises more economically feasible. By contrast, the
CERES project has been reluctant to engage with local councils based on the bureaucratic barriers it had
encountered on previous occasions. As the CERES director states that, with regards to building such
projects it is often, ‘better to ask for (council) forgiveness than to seek permission’. This is surprising given
the relevant councils cover large areas of Melbourne’s socially progressive (and increasingly affluent)
inner north areas, moreover, with strong reputations for ‘foodie’ culture and environmental awareness. It is
possible that the strong regulatory food regime in Australia, including costs of licensing and compliance
coupled with the perceived lack of food insecurity, inflated land prices and relative high employment in
other sectors, serves to dissuade local officials from fostering urban agriculture enterprises at any scale.
Overall this suggests that urban aquaponics, as an enterprise with modest but ongoing financial and
human resource requirements, is more likely to succeed in cities that have broader incentives to develop
viable business models.

Urban Aquaponics and Government Policy
Influence and Impact

Given both projects commenced around the same time, between 2008 - 2010, a significant factor to
date in affecting the success has been the external policy and governance environment. The city of
Milwaukee has supported Sweet Water Organics both through policy initiatives and direct financial aid.
In contrast, the CERES project has met with, at best, apathetic local administration, ‘we are not dealing
with a council where they are super proactively encouraging innovation’, said one interviewee. Costs of
compliance and process licensing means that there are no plans to market the fish produced by the
aquaponics project. As one interviewee suggests, the whole project is ‘a work in progress’. Technical
difficulties, combined with macro-factors such as cheap subsidised water for industrial agriculture, has
made it untenable for the operation to develop beyond a small part-time income generating enterprise.
This suggests that, given its highly experimental technical and commercial character today, strong ongoing government support, both financially and legislatively, is a critical factor to fostering successful urban agriculture and hence aquaponics social enterprises.

Both cases also draw attention to the challenge they see in establishing themselves as viable contributors to national and international food production when faced with market competition from established broad acre, mono-cultural farming enterprises that can often receive substantial government subsidies despite their unsustainable and highly resource dependent production and distribution methods (Ackerman Leist 2013). I have noted that while none of the CERES survey participants highlighted ‘restrictive government policy’ as a barrier to their economic feasibility, both key informants who participated in the interviews did talk about the challenge of competing in the current market where prices do not accurately reflect the environmental cost (both today and in the future) of production. A CERES interviewee argues Australians are ‘living in a heavily subsidised world where we are utterly unaware about the cost of our own existence’. They stated that until this is balanced out through legislation and policy incentives small farmers will struggle to compete with market giants. This sentiment is echoed in a comment made by a SWO survey participant that the objectives of SWO were in part forced to change from operating as a stand-alone urban primary producer, on account of

the cheapness of competing ‘conventional’ foods who are subsidized by all of us, (whereas)

environmental costs are considered ‘externalities’ absorbed by the general populace, et cetera.

While neither case is engaged with government at a state or national level they are both working on various levels educating schools and communities about the benefits of eating locally grown fresh foods. This strategy would suggest that, if successful in creating a viable alternative, in the long term they are
effectively creating their own market as the awareness and appreciation grows for localised produce and production.

Sustainable Development and Social Enterprise
Experiments and Research

The experimental nature of both operations is strongly evident in each set of interviews and survey responses, with respondents in both cases referring to various experiments with system housing, system calibrations, organisational structure and trials of fish and vegetables. While the overall objectives of both cases are similar, they have built their systems with different purposes in mind. This is reflected in their distinct size, prospects and directions in growth. In retrospect, it has become clear that the objectives provided in the survey multiple choice are more reflective of long term goals. Fortunately participants have clarified their more short to medium term objectives in the comments section. These objectives are supported by data collected from interviews with key informants. True to the experimental nature of the projects, they have both been through many changes and adaptations on a number of levels as they strive for sustainability.

The CERES aquaponics project was built as a ‘sub-optimised model’ that was designed to be replicable and affordable, and at the same time capable of demonstrating its ability to provide ongoing employment to one farmer. In one instance, to reduce energy demands, a natural aeration system was used. However, as this was unable to provide enough air into the water for the fish, an artificial aeration system was introduced. There have also been issues with the filtration that are still being refined.

In the case of Sweet Water Organics, the initial construction took place inside a converted warehouse. Deep rectangular tanks were dug into the floor with three levels of vegetables above in floating rafts in shallow beds. Due to the inefficient filtration systems of its original design, estimates for the fish to plant
ratio were poorly calculated, with five times as many plants needed to support the number of fish initially introduced to the system. There were also substantial electricity costs due to inefficient design. A SWO founder stated that, in retrospect, it was a mistake to use the (GP) model, because ‘that model is not a model for commercial scale aquaponics whether is be inside a greenhouse or inside a factory building’. Responding to these setbacks the system has since been moved outdoors and upgraded to a more tried and efficient model. The fish were kept in large circular tanks and a separate greenhouse environment has been built for growing vegetation in deeper beds allowing for better nutrient uptake and filtration. Based on what they have learned they have also designed a new filter for increasing fish health and production capacity. In both of these instances, preliminary research during the design and planning stages of these projects would have allowed them to avoid the costly adaptations and setbacks associated with these ‘experiments’.

Both projects have also experimented with a number of organisational models. The SWO setup is notionally 'for-profit' (FP), though it is yet to realise positive cash flow. The affiliated not-for-profit (NFP) SWF, which operates under a different business model to SWO, provides a means for the business to apply its aquaponics knowledge to enhance education in Science, Technology, Engineering, Arts and Mathematics (STEAM) programs, building community awareness and communicate its research findings. To date SWO has been heavily dependent upon both grants and low-interest, forgivable loans. However, as a For-Profit enterprise, turning a profit is a priority, and, as one survey recipient pointed out, ‘SWO has an objective of becoming profitable’. It is currently looking to generate positive cash flows through the diversification of crops beyond aquaponics produce. It is possible that the clearly defined Not-For-Profit structure of the Foundation has been pivotal in maintaining both internal consensus and the unconditional philanthropic contributions from a range of private and public donors. Survey responses suggest that the reconciliation of priorities between these two organisations has also posed significant challenges to achieving a consensus of objectives of each operation as a whole. Based on this information,
I asked one respondent about the objectives and strategic planning methods used across the SW hybrid. They initially replied that I had ‘touched on a sensitive button’ and went on to say that strategic planning was done by their respective boards who preferred to operate independently. To manage the challenge of not always sharing the same organisational vision and strategy, the success of the SW FP and NFP hybrid organisational model has been attributed to the sharing of common board members who are responsible for maintaining communication and awareness between the two.

Finally, both projects have trialled different remuneration schemes, with what appears to be varying success. In the case of CERES, the current operator takes all of the income generated by the system. Payment of rent on the property has been deferred until the system is operating at full capacity. Given the size of the operation, the introduction of a substantial new overhead could be a major challenge unless further sponsorship or grant funding can be found. In the case of Sweet Water, it currently appears to have a high enough cash flow to cover staff costs, albeit at a lower hourly rate than staff expertise would ordinarily dictate. Overall it has higher overheads and staffing costs than CERES, as well as greater prospects for growth.

In spite of their differences, though, these findings show that both SEs have been valuable incubators for technical and financial innovation.
Economic Sustainability in Social Enterprise

As the preceding section shows, the field and nature of social enterprise and the role it plays in achieving sustainable development is still largely experimental in both design and approach. As noted in the literature review this clearly can be beneficial, as creative narrative and action can serve to inspire popular support and overall social change. However, it can also present challenges when the altruistic narrative is pushed to outweigh realistic projections for the purpose of gaining support (including social, political and financial) and attention. In a worst-case scenario it can serve to undermine the integrity and sustainability of the whole operation.

In spite of Sweet Water’s notional status as a 'for profit' enterprise, both projects have also leaned heavily upon volunteer time to establish and maintain their respective aquaponics systems. It is also a weakness incumbent upon social enterprises that require ongoing maintenance, as is certainly the case with aquaponics. Without the strong incentive of income, the initial enthusiasm of altruistic volunteers can dissipate quickly, causing stress for management and decision making systems. At the same time, it is also a critical strength, since without the dedication, enthusiasm and vision of volunteers neither project would have become established. As one of the SWO founders claimed, ‘commercial ventures do not attract or inspire pro-bono genius like social enterprise committed to multiple (ecological and social justice) bottom lines’.

While pragmatic in outlook, Sweet Water stakeholders hold greater commercial hopes for their operation in Milwaukee. To date energy costs have played a major determining role in the viability of the business; they anticipate the new outdoor installation will have lower costs, but also need to monitor the produce profile. In the words of the SWO Milwaukee City Director, 'we make money off every sprout and lose money on every head of lettuce because of energy costs'. As discussed above, there are also
plans to diversify revenue streams, to have, as one of the founders put it, 'multiple bottom lines, multiple income streams'.

SWO was initiated solely as a ‘for profit’ enterprise, promising that on account of its system size (rather than proven production capacity) it would be capable of employing a large number of people. In 2011 they were obliged to seek financial assistance to pay for the outstanding wages of four employees bringing their business ethics and capabilities into question (Daykin 2012). Assistance came from the Milwaukee City Government in the form of a US$250,000 ‘forgivable loan’ with strict conditions of creating 40 jobs over the next four years which, in hindsight, was unrealistic, given a despondent national economy and an untried technology and industry. Again, based on these unrealistic projections and timeframes, SWO was forced to renegotiate its financial capabilities and projections to remain afloat. Ultimately this effort proved unfruitful. In May 2013, the ‘for-profit’ part of the enterprise had gone into administration.

More broadly, various stakeholders expressed the hope that commercialisation would remain a means rather than ends for Sweet Water: a demonstration of a feasible, locally-owned and operated venture that can both pay its bills, and provide employment, food security and diversity, and ecological education to the citizens of Milwaukee. As one of the current managers described the inspirational value of the enterprise, ‘they say it’s worth a million bucks but it’s worth much more than that’.

In spite of the adverse media Sweet Water attracted in 2010, both projects had relatively ‘frictionless’ stakeholder operations to date. This is particularly surprising in the case of SWO, given the higher stakes and range of skills - technical, administrative, pedagogical, and increasing, commercial - that need to cooperate for the enterprise to succeed. In part this may be explained by the maturity and enthusiasm of many of the stakeholders, who bring to the operation many prior years of experience - and again, the
positive support from the City of Milwaukee and the broader business community seems to foster positive collaboration.

The CERES project has had less success or incentives in building awareness and markets for its produce. Accordingly it has been maintained to a large extent by volunteers. A farmer is paid the direct weekly earnings of the produce at the affiliated CERES Fair Food organic box service, while the Director of the facility only receives payment to the tune of one hour per week. Extra time, energy and resources would be needed to facilitate the growth and development of the project. Aquaponics poses particular challenges compared with horticultural UA, since it requires daily attention throughout the year. Volunteers are naturally less willing or able to commit to such a demanding timetable. Equally, employees can struggle with the fact that their income can vary dramatically. Initially produce was sold through a profit-sharing arrangement between the operator and CERES Fair Food; the operator eventually became discouraged and exhausted with the lack of returns and left. The current farmer now keeps all the profits due to the low volumes of produce. This is the only way to keep the facility viable. However, the facility is providing an income to one person as proposed from the outset.

**Factors for Success**

A common challenge for both projects has been managing the resource-intensive nature of aquaponics installations. Initial capital for the installations was raised through a combination of grants and private donations in both cases, though Sweet Water has since managed to raise loans through its municipality as well. On account of their experimental nature, which reflects the absence of tried and proven commercial aquaponics systems, both have also been required to make numerous and sometimes expensive adaptations. These trials and errors are valuable, though one CERES interviewee did suggest that the
aquaponics industry would benefit from better internal collaboration and reference to existing research so that ‘we don’t continue to keep trying to reinvent the wheel’.

Both projects also boast the ongoing involvement of highly committed founders. The founder of Sweet Water appears to play an advisory rather than executive role currently, while the CERES aquaponics founder continues to oversee a considerably smaller operation. The role of founders can often be problematic in both business and social enterprises contexts. Yet in both cases the founders remain instrumental in continuing to guide their respective start-up stages.

Both projects have had variable success developing sustainable markets. Sweet Water has a loyal following among local restaurateurs and fresh food stores for its lettuce and sprouts produce, and sells its fish to a single wholesaler, reducing costs of distribution, marketing and sales. Similar to SWO, CERES is not operating at a scale that would generate a return to cover the costs of setting up a fish processing facility, although they have not investigated potential avenues for selling the fish wholesale or otherwise. The sale of the vegetable produce is currently generating enough revenues to cover the costs of the sole operator. Building greater awareness of the broader environmental and social benefits of urban aquaponics has been a goal in both cases – though, demonstrated by the readily received work of SWF, the Milwaukee context appears more conducive to this message.

While little to no market research was done in either case, it is clear that over time an awareness has developed of the need to consider not only what to grow but how much the system can produce and how much is needed for the operation to be viable in either a wholesale or retail market. The approach chosen has considerable implications on day-to-day operations and workload distribution. In both cases there has been preference for retail market because of high returns for less produce. However, this can also be considered somewhat unreliable unless the enterprise has reliable relationships with a large enough number of buyers. The maintenance and establishment of these relationships takes time and
energy. Relationships are more easily established, in these two cases, when there is a culture of appreciation and preference for locally grown produce. As one SWO interviewee stated, ‘if you are a new restaurant in the city you should probably have local produce on the menu if you want to be competitive’. This culture is definitely more obvious in the case of Milwaukee, where the sale of their produce was facilitated by lower levels of competition. Both cases are collecting data on system input and outputs for the purpose of informing future system design and, in the case of CERES, for making funding applications.

In addition to the associated Foundation, Sweet Water is also looking at monetising both the expertise and intellectual property generated through the business itself. These could conceivably take the forms of consultancies and copyright licensing in the future, though such plans have yet to be formalised. CERES has also secured funding to develop a project taking aquaponics into schools. However, this money is reliant on the farmer and volunteers conducting research to demonstrate the system’s viability. Since the farmer is naturally more interested in maximising production, this research is developing slowly. Such research, if properly documented and freely shared, could serve to facilitate the growth of similar enterprises.

**Social and Technical Factors Identified in Urban Aquaponics SEs**

In the table below I highlight significant factors that appear to play a role in the sustainable establishment of similar enterprises. The table offers a logical framework for establishing a community focused, urban aquaponics enterprise. It draws on the two cases to show key comparative technical, social, political environmental and economic elements of each case according themes identified in the literature review, visits to each site as well as the survey and interviews I conducted with key stakeholders.
While the circumstances of all new urban aquaponics enterprise will inevitably vary to some degree, the factors I have identified could allow future operators to establish a checklist for a successful urban aquaponics enterprise, based on their own contexts and stakeholders. Further work would be necessary to determine whether these factors are indeed essential to the success of other operations.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>FACTORS</th>
<th>SWO</th>
<th>CERES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td>Location</td>
<td>City of Milwaukee, USA</td>
<td>City of Melbourne, Australia</td>
</tr>
<tr>
<td>Organisational</td>
<td>Business and governance model</td>
<td>For-profit/Not-for-profit Hybrid.</td>
<td>For-profit enterprise project within CERES Not For Profit.</td>
</tr>
<tr>
<td>Technical</td>
<td>Aquaponics System Efficiency</td>
<td>First and second models not efficient enough for commercial production. Third model designed and built by external consultants. Unproven as yet.</td>
<td>Not operating to capacity and still needing ongoing support from aquaponics expert. Providing modest income to one farmer.</td>
</tr>
<tr>
<td>Technical</td>
<td>System Produce</td>
<td>Lettuce (Micro-greens), Fish (Yellow Perch, Tilapia), Herbs.</td>
<td>Lettuce, Herbs, Fish (Silver Perch, Trout).</td>
</tr>
<tr>
<td>Economic</td>
<td>Market Research</td>
<td>Basic.</td>
<td>None.</td>
</tr>
<tr>
<td>Socio-Economic</td>
<td>Market Outlets</td>
<td>Local Restaurants, Food Stores, SWO retail shop. Fish sold wholesale to processing facility.</td>
<td>CERES 'Fair Food' Organic box delivery. Fish not marketed or sold.</td>
</tr>
<tr>
<td>CATEGORY</td>
<td>FACTORS</td>
<td>SWO</td>
<td>CERES</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Social</td>
<td>Community Support</td>
<td>Strong.</td>
<td>Basic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Large number of volunteers and interns. Substantial support from local government, philanthropists and school grant programs.</td>
<td>Although forms part of organisation with strong community support. No capacity to support volunteers. Limited government support.</td>
</tr>
<tr>
<td>Social</td>
<td>Community Engagement</td>
<td>Strong.</td>
<td>Basic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strong and growing presence in schools and education enhancement programs. Runs weekly community/school tours. Significant local government engagement and funding.</td>
<td>Offers preliminary aquaponics workshops at the site. Runs tours as a part of CERES. No government engagement at any level.</td>
</tr>
<tr>
<td>Economic</td>
<td>Additional revenue streams</td>
<td>Yes. Future economic projections based on income from sprouts.</td>
<td>No. Although experimenting with diversifying crops.</td>
</tr>
<tr>
<td>Technical/Education</td>
<td>Ongoing aquaponics research</td>
<td>Planned. Re-establishing relationship with UMW School of Fresh Water Sciences.</td>
<td>Yes. Monitoring inputs and outputs over a year. Although challenging to sustain amidst other daily demands.</td>
</tr>
<tr>
<td>Economic</td>
<td>Independently Economically Sustainable based on Aquaponics production output</td>
<td>No.</td>
<td>Yes.</td>
</tr>
</tbody>
</table>

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CONCLUSION

The Milwaukee and Melbourne urban aquaponics social enterprises have demonstrated that it is possible to sustain urban aquaponics enterprises beyond a start-up phase of five years. Both projects have experimented extensively with different configurations of housing, equipment, and fish and vegetable species. Similarly they have explored a range of social structures and incentives to remain in operation.

In both cases profiled, urban aquaponics remains challenging. Expertise and infrastructure for building more than hobbyist-scaled aquaponics systems are more common in developed cities like Milwaukee and Melbourne. Both the US and Australia also have considerable traditions in areas of agricultural innovation generally. It is therefore not surprising that two moderate-scale urban aquaponics social enterprises have been started in these cities. However, results of my interviews, observation and surveys show that there have been considerable challenges for these enterprises as they approach five years of operation.

Both sets of interviews reference continued trial-and-error experimentation with the technical designs of their respective urban aquaponics installations. It appears that at least at the ‘meso’ scale of social enterprise - neither backyard hobbyist nor full-blown industrial - urban aquaponics has yet to settle into a paradigm of ‘normal science’ with a set of established equipment and operating procedures to follow. Any future commercial aquaponics projects would benefit enormously from drawing on research of viable scales of production for either the retail or wholesale market. In this respect, the CERES project had the advantage of an aquaponics expert who was on-hand to advise in the set-up of the initial installation. However, the greater scale of Sweet Water has meant that it has had the resources to redesign from scratch two times, and has reasonable confidence that its latest design will allow for the greater
efficiency and lower overheads to make the operation cash-flow positive. In terms of the broader
benefits of this technical experimentation, both projects have indicated a willingness to share data and
results of their current installations, though Sweet Water is concerned, to a much greater degree, with
safeguarding its intellectual property rights.

My study shows a number of factors are significant to their survival to date. These have been summarized
at the conclusion of my results, and make a promising start for a checklist for future aquaponics
operations. Principal among these is the ongoing commitment of key stakeholders. It has been critical that
both enterprises have had continued support of personnel with technical and business management skills
combined with an enduring leadership. Equally important is that these stakeholders have remained
involved and prepared to cooperate with each other without strong financial incentives, and in the face
of technical and political challenges. This is often the case in successful social enterprises where, despite
the need to be economically viable, the driving energy for the project comes from the desire to bring
about social change and to stimulate a transition towards a system that measures wealth and health and
sustainability in other than purely financial terms.

Despite this underlying motivation, this research shows that the trials of farming using an untried
production technology that has no successful commercial precedent in the urban context – combined with
the lack of technological expertise and research in the design of their systems – has caused both
enterprises to flounder and struggle to achieve economic viability. In part, this has come about on account
of the limited availability of research-based knowledge, experienced individuals and tried technology in
this field of aquaponics. It has also been triggered by the limited research undertaken by both parties
into available market opportunities and ‘best practice’ system technologies prior to commencing their
ventures. This has had a significant impact on their ability to gain economic traction in their start-up
phase. Indeed, at the time of writing (June 2013), the ‘for-profit’ side of SWO had gone into administration.

A further factor I identified is the local political context. In the case of the city of Milwaukee, strong financial and legal support has allowed SWO to expand its fixed assets and human resources, build market awareness and acquire a sizeable regular commercial customer base. The CERES project, by comparison, has had little such support beyond an initial grant, and has struggled to generate revenue to expand the project. This in turn has clearly dampened its motivation and ability to market and sell fish. A positive government environment and relationship clearly provides more opportunity for urban aquaponics social enterprises to reach produce volumes that justify initial capital expenditure. However, its resulting low cost-base has made this model more resilient to date. While aspects of the SWO operation may yet continue, SWO’s recent collapse suggests that their initial political support had not been enough to develop to a point of self-sustainability.

The availability of markets for urban aquaponics produce also proved to be highly relevant. While the urban aquaponics ‘story’ is attractive to a customer base that is increasingly responsive to issues of food security and ethical consumption, the CERES example suggests that this story needs to be refined and developed even for Melbourne’s sophisticated inner-north consumers. As one of our respondents suggested, this may well be because the hidden food production costs of water and energy are externalised in many developed world countries, including Australia. The sustainability of urban aquaponics enterprises needs corresponding political and social demand-side support that would be greatly facilitated through political advocacy, community education and existing examples of viable systems.

As both cases work to achieve economic sustainability, the full potential of aquaponics as a tool for sustainable community development and education in cities has yet to be proven. My findings do suggest,
however, that through strong community networks and outreach opportunities, potential markets can be created as people become aware of the benefits of accessible, locally grown fresh produce. The broader literature has, moreover, argued that urban agriculture, by providing local communities with access to urban farms and technology, can result in social learning and lifestyle benefits – what Goerner et al. (2009) refer to as producing ‘more socially, economically and environmentally sustainable wholes’. Building networks and sustained community engagement, however, take time and energy. As demonstrated by the high levels of personal commitment engagement in the SWO and CERES Aquaponics cases, incentives to sustain such innovation is often motivated by an awareness of its contribution to the community. At least during the start-up phases of these enterprises, all stakeholders, including local governments and consumers, need to be aware of multiple bottom lines for evaluating these enterprises. As Goodman (2011) argues, ‘if the (aquaponics) system in question was not efficient enough to be profitable…thought should be given if the community and economic benefits of the system are enough to justify the costs’.

Overall, the experiences of these two projects show that urban aquaponics is now a tantalising prospect for social enterprises looking to build sources of food security and sovereignty for cities. The success of such enterprises is greatly enhanced by a strongly supportive government environment - one that is willing to share some of the risks. The technical methods for managing moderate-scale aquaponics are slowly coming of age, and increasingly, these can be readily adopted by both volunteers and professionals. The exact form and financial model of social enterprises is less clear. The split for-profit/non-profit structure of SWO introduces higher overheads and potential tensions between stakeholders, while the profit-sharing model of CERES is challenging due to the lack of a ‘critical mass’ market. This remains an open question for urban aquaponics social enterprises, and further social experimentation in this area is expected in the years ahead.
APPENDIX 1 – AQUAPONICS SURVEY
Urban Aquaponics Research. Sweet Water Organics

This questionnaire is a part of study being conducted in to identify conditions and actions that appear to support or inhibit the growth of urban aquaponics enterprises. To understand more about this questionnaire and the research of which it is a part of please read the Research Participant Information Form attached to the email sent to you containing the survey link.

Do you consent that the information you provide in this survey be used for the research described in the Research Participant Information Form?

- Yes
- No

1) How Long have/did you work with Sweet Water Organics? *
   - <6 months
   - <12 months
   - <18 months
   - <2 years
   - Since it’s inception

2) What was/is your role with Sweet Water Organics?

3) In this role are/were you? *
   - A paid employee
   - A volunteer
   - A volunteer and then paid employee
   - None of the above

4) If none of the above please provide alternative explanation

5) If you are no longer involved with Sweet Water Organics, please explain why this is.

Project Objectives

6) How clear to you are the key objectives of Sweet Water Organics? *
   - Very unclear
   - Rather unclear
   - Rather clear
   - Very clear

form.jotform.com/22327010508377
7) In your understanding, what are the key objectives of Sweet Water Organics? (Please mark all boxes that apply) *
□ to increase local food security
□ to build employment capacity
□ to provide employment opportunities
□ to stimulate urban regeneration
□ to create a sustainable urban environment
□ to provide a venue for applied research in Aquaponics

8) Please identify any other objectives you are aware of not included in the list above

9) In your opinion, have these objectives changed over time? *
□ yes
□ no

10) If you answered 'yes' what do you think has triggered this change?

11) In your opinion, is there consensus amongst those involved in the Sweet Water Organics as to what the key objectives are? *
□ yes
□ not sure
□ no

The Broader Community

12) Based on your experience with Sweet Water Organics what sectors of the broader community have expressed their support for its development? (Tick all boxes that apply) *
□ Local Government
□ State Government
□ National Government
□ Philanthropic Organisations
□ Educational organisations/School
□ Community development and support groups
□ Members of the Food industry
□ Community Sustainability and Environment Groups
□ Academic Institutions

13) Please name any supportive sectors you are aware of that are not included in the list above

form.jotform.co/form/22397010058387?
14) Based on your experience what sectors of the broader community have been actively engaged with Sweet Water Organics in any way? *

☐ Local Government
☐ State Government
☐ National Government
☐ Philanthropic Organisations
☐ Educational organisations/School
☐ Community development and support groups
☐ Members of the Food industry
☐ Community Sustainability and Environment Groups
☐ Academic Institutions

15) Please identify any sectors that have been engaged in Sweet Water Organics you are aware of that are not included in the list above

Sustainability.

16) In your personal opinion how do you feel these elements should be prioritised in development projects? *

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<thead>
<tr>
<th></th>
<th>most important</th>
<th>moderately important</th>
<th>least important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Sustainability</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Social Justice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic Growth</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17) Based on your understanding of and engagement in Sweet Water Organics what do you see are the priorities in its development? *

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<thead>
<tr>
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18) Based on your understanding of the local government and its engagement in Sweet Water Organics what do you see as their priorities in local development projects? *

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19) Based on your understanding of the local community and its engagement in Sweet Water Organics what do you see as their priorities in local development projects? *

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Urban Aquaponics Research: Sweet Water Organics

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20) What do you think are the reasons why these priorities are different (if they are)?

Challenges

21) Which of these external issues have presented challenges for Sweet Water Organics? Tick all boxes that apply

- lack of community support
- lack of community engagement
- restrictive government policy
- limited funding
- limited market opportunities for sale of produce
- limited size of production capacity
- weather
- physical location (i.e. rent, insecure tenure, spatial restrictions)
- limited availability of research based knowledge of Aquaponics
- limited government support
- lack of investment in and development of aquaponics related technology

22) Please identify any external challenges not included in the list above

23) Which of these internal issues have presented challenges for Sweet Water Organics? Tick all boxes that apply

- poor organisation
- unclear governance
- unclear direction
- perceived financial mismanagement
- limited paid employment capacity
- depending on volunteer workforce
- conditional funding
- lack of consensus on objectives
- limited market research and awareness
- communication
- limited availability of aquaponics industry technology and research based knowledge
24) Please identify any internal challenges not included in the list above

Achievements and the Future

25) What do you see as the achievements of Sweet Water Organics? Tick all boxes that apply.*
- documented aquaponics research
- aquaponics education
- community engagement
- engagement and success within the food industry
- pioneering urban aquaponics
- great organisational culture and solidarity amongst workers/volunteers
- providing sustained and growing number of employment opportunities
- sustained localised fresh food production
- developing educational programs
- developing community awareness of sustainable/healthy living
- building of local network and alliances
- building of international networks and alliances
- developing a new business model
- developing new aquaponics technology
- success in pushing for change in government policy with regards to urban food production
- having fun

26) Please identify any achievements not included in the list above

27) What else will be needed to establish a sustained and growing urban aquaponics industry in the future?

28) Do you have any other comments on Sweet Water Organics?
Thank you very much for taking the time to complete this survey.
APPENDIX 2 – INTERVIEW QUESTIONS

• What is your role at SWO/CERES?
• What is your previous experience with Aquaponics?
• How/why did you get involved with the organisation?
• How/why did the project start?
• What are the objectives of the organisation?
• Do you feel there is consensus amongst members with regards to the objectives of the organisation?
• How is the organisation structured? Why is it structured this way?
• How are decisions made and conflicting priorities amongst members addressed?
• Why aquaponics selected as the farming technology to be used?
• Tell me about the aquaponics systems at SWO/CERES Aquaponics.
• Was there any research regarding the system before it was built?
• What are the challenges in setting up a farm in an urban setting?
• Was there any market research conducted before the enterprise?
• Who, from the broader community, has been involved/supportive of the enterprise?
• Does your city/local government have a food security/UA policy?
• What are some of the barrier you have faced in establishing the enterprise? (political, social, environmental, spacial, economic)
• What do you see as the future of farming in your city?
• Does aquaponics have a role to play in this future?
• What is needed to facilitate the growth of the industry?
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