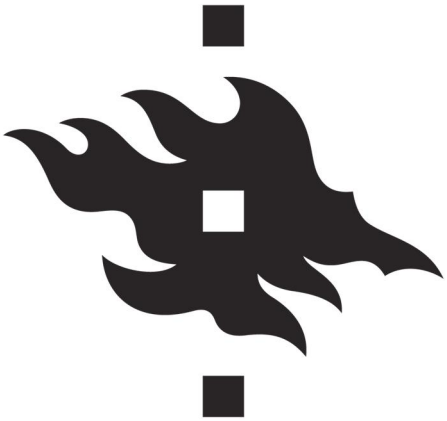

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Understanding the Perceptions of Urban Citizens Concerning a Forest-based Bioeconomy

Faculty of Agriculture and Forestry
Department of Forest Sciences
Forest Economics and Marketing
Master's Thesis
Tuuli Suomala
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Tiivistelmä/Referat – Abstract

Bioeconomy is a concept that aims to provide sustainable solutions for economic growth by utilizing renewable natural resources. In Finland, the forest-based bioeconomy forms the base for bioeconomy. The Finnish Bioeconomy Strategy by the Ministry of Employment and the Economy has set ambitious targets regarding employment, output and innovative products and services. However, to date these solutions still remain by large in the theoretical level and the overall sustainability of bioeconomy is questioned by stakeholders.

Urbanization is a world-wide phenomenon and also in Finland the biggest cities are expected to grow whilst the country-side becomes less inhabited. Thus, the importance of urban citizens becomes increasingly important in the implementation of forest-based bioeconomy, as they are the future consumers of biobased products and practices. Thereby understanding urban citizens' perceptions, level of knowledge and opinions regarding the emerging bioeconomy practices is of fundamental importance. This thesis aims to provide insights into the topic with the research questions "what are the worldviews through which urban citizens understand the forest-based bioeconomy?" Furthermore, this thesis aims to provide insights into the question, "how do these worldviews affect the urban citizens' perceptions of the forest-based bioeconomy?" These worldviews are screened through the Integrative Worldview Framework (IWF) to explain and understand the underlying latent elements of perceptions and acceptance. Additionally, this thesis contributes to a European-wide research network aiming to understand the regional disparities of forest-based bioeconomy perceptions and policies.

To answer these questions, a quantitative survey was conducted in Helsinki city center in December 2018 and January 2019. The survey included 34 claims regarding wooden multistory buildings, forest carbon storage and forest-based bioeconomy. With a randomized approach, 206 responses were gathered in total. The statistical methods include descriptive statistics, crosstabulations and exploratory factor analysis and were done using the SPSS 25 Programme.

The results proved to be positive and encouraging for the Finnish forest-based bioeconomy. Four worldview factors were detected: Utilitarian, Biocentric, Anti-bioeconomy, and Anthropocentric. Nearly 59% of the respondents perceived to be familiar with the meaning of forest-based bioeconomy and even more with both wooden multistory buildings (WMC) and forest carbon storage. Additionally, forest-based bioeconomy was associated with positive attributes such as generating new jobs and wellbeing.

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forest-based bioeconomy, urban citizens, perception, factor analysis, Integrative Worldview Framework

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Tiivistelmä/Referat – Abstract

Biotalous tarkoittaa taloutta, joka pyrkii luomaan kestäviä ratkaisuja uusituvia luonnonvaroja käyttämällä. Suomessa metsäbiotalous muodostaa biotalouden perustan. Suomen biotalousstrategiassa on asetettu kunnianhimoiset tavoitteet työllisyydestä, talouskehityksestä sekä uusien innovatiivisten tuotteiden ja palveluiden kehittämisestä. Kuitenkin nämä ratkaisut ovat vielä laajasti teoreettisella tasolla ja biotalouden yleistä kestävyyttä kyseenalaistetaan.

Kaupungistuminen on maailmanlaajuinen ilmiö ja myös Suomessa suuret kaupungit kasvavat samalla kun maaseudun väestö vähenee. Täten kaupunkilaisväestön tärkeys biotalouden tuotteiden ja ratkaisujen loppukäyttäjinä kasvaa, ja heidän käsitystensä, tietotason ja mielipiteidensä ymmärtäminen on olennaista biotalouden käytänteiden jalkauttamisessa. Tämä tutkielma pyrkii vastaamaan kysymyksiin “mitkä ovat maailmankatsomukset, joiden kautta kaupunkilaiset ymmärtävät metsäbiotalouden?” ja ”miten nämä maailmankuvat vaikuttavat kaupunkilaisten käsityksiin metsäbiotaloudesta?” Näitä maailmankuvia tulkitaan Integrative Worldview Frameworkin (IWF) avulla, joka auttaa ymmärtämään paremmin käsitysten ja hyväksynnän taustalla olevia tekijöitä. Lisäksi, tämä tutkielma ottaa osaa Euroopan laajuiseen tutkimusprojektiin, jossa pyritään ymmärtämään alueellisia eroja metsäbiotalouteen liittyvistä käsityksistä ja käytänteistä.

Tutkimuksen empiirinen osa koostui määrällisen kyselyn toteuttamisesta Helsingin keskustan alueella joulukuun 2018 ja tammikuun 2019 aikana. Kyselylomakkeessa oli 34 väittämää puukerrostaloista, metsien hiilensidonnasta ja metsäbiotaloudesta. Satunnaisotannalla kerätty kysely tuotti 206 vastausta. Tilastolliset laskennat suoritettiin SPSS 25-ohjelmalla ja metodeihin sisältyivät kuvailevat tunnusluvut, ristiintaulukointi ja eksploratiivinen faktorianalyysi.

Tulokset olivat positiivisia ja kannustavia Suomen metsäbiotalouden liiketoimintaympäristön kehittämisen kannalta. Faktorianalyysin pohjalta löydettiin neljä maailmankuvaa – Utilitarismi, Ympäristökeskeinen, Biotalousvastainen ja Ihmiskeskeinen. Lähes 59% vastaajista koki tuntevansa metsäbiotalouden merkityksen, ja vielä useampi sekä puukerrostalojen että metsien hiilensidonnan käsitteet. Lisäksi metsäbiotalous liitettiin positiivisiin tekijöihin kuten uusien työpaikkojen ja hyvinvoinnin luomiseen.

Avainsanat – Nyckelord – Keywords
metsäbiotalous, kaupunkilaiset, käsitykset, faktorianalyysi, Integrative Worldview Framework

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Contents

1 Introduction

1.1 Background

In October 2018 the Intergovernmental Panel on Climate Change (IPCC) released their "Special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways." According to the IPCC (2018), global warming will most likely reach 1.5°C between 2030 and 2052, contributing to e.g. extreme weathers, sea level rise, species loss and ocean acidification. Climate change is in large part driven by human actions (United Nations, 2019); for example, the global middle class will soon be larger than ever, having both ecological and social implications (Kharas, 2017). Forests play an important role in mitigating the climate change as they remove CO_2 from the atmosphere, store carbon and offer renewable substitutes for fossil fuels and other nonrenewable materials (Lundmark et al., 2014; Kurz et al., 2016). Hence, forest resources have a considerable meaning in achieving climate goals in the European Union (EU). Over 40 per cent of the EU's land area is covered in forests or other wooded land (European Union, 2011), while Finland is the most forested country in EU by land area (Domínguez et al., 2015, p. 70).

Bioeconomy as a concept has gained wide interest in the past few years and the discussion revolving around it has increased significantly both in research and in political contexts (Staffas et al., 2013; Pfau et al., 2014; Pülzl et al., 2014). The origins of bioeconomy on a European level can be traced back to the 1970s and the 1980s to the first biotechnology oriented reports and framework programs (Aguilar et al., 2013; Patermann & Aguilar, 2018). In the early 21st century the number of scientific articles concerning bioeconomy has increased considerably (Bugge et al., 2016), and already in 2000 biotechnology was identified as an important opportunity for forest industry (Laestadius, 2000).

Currently bioeconomy has become one of the most important policy priorities. The European Commission's Bioeconomy Strategy (2012; 2018) defines bioeconomy as covering all sectors and systems which are dependent on biological resources; this includes agriculture, forestry, fisheries, food, pulp and paper industries as well as parts of the chemical and energy industries and biotechnology. Bioeconomy was given five

main strategic objectives: ensuring food and nutrition safety, managing natural resources sustainably, reducing the dependency on non-renewable unsustainable resources, mitigating and adapting to climate change and strengthening European competitiveness whilst creating jobs (European Comission, 2018). In general bioeconomy can be understood as an economy which utilizes renewable natural resources as industry raw materials, food, chemicals and energy sources (see e.g. McCormick & Kautto, 2013; Ollikainen, 2014). Nevertheless, bioeconomy has several different definitions depending on which context and who is talking about it and the definition remains to be open (see e.g. Schmid et al., 2012; McCormick & Kautto, 2013; Pfau et al., 2014; Bugge et al., 2016).

In Finland, the forest sector forms the base for bioeconomy. Of the total land area 86% is considered as forestry land, and in 2016 forest industry products accounted for 22% of the total export of goods adding up to 11.5 billion euros (TEM, 2014; LUKE, 2017). In 2011 bioeconomy accounted for 16% of the national economy's output, meaning more than €60 billion, and employed over 300 000 people (TEM, 2014), and in 2017 the numbers were approximately the same (LUKE, 2018a). Forest sector is the strongest operator in Finnish bioeconomy as it provides 40% of the bioeconomy output and value added (LUKE, 2018b).

Additionally, forests have an important role in the Finnish Bioeconomy Strategy that aims to generate welfare and competitiveness via sustainable solutions (Sitra, 2009; TEM, 2014). Figure 1 illustrates the main strategic goals. The Finnish Bioeconomy Strategy (TEM, 2014) was published in 2014 and it aims to raise the bioeconomy's output to €100 billion and create new employment to 100 000 people by year 2025. In other words, the Strategy aims to extend the bioeconomy businesses' operational environment and create more high value added products whilst protecting the nature's ecosystems (TEM, 2014). However, it remains unclear what these sustainable solutions in practice mean and how they are implemented to the business-as-usual situation. Further, also the actual increase in employment faces challenges in e.g. attracting new students and low diversity of the workforce (Lawrence et al., 2017). It has been stated that the emergence of complete bioeconomy value chains and clusters will be a long-term process (Tahvanainen et al., 2016).

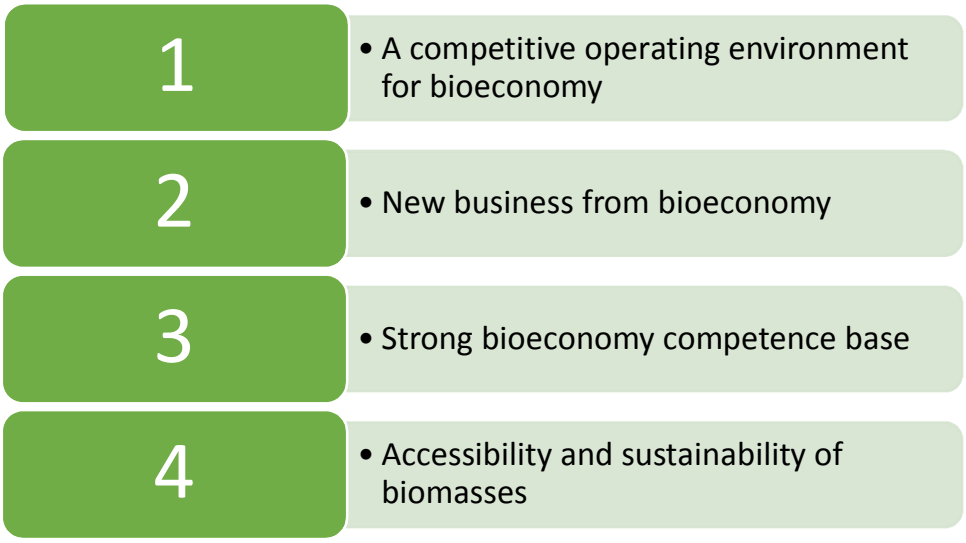

Figure 1. Strategic goals of the Finnish bioeconomy strategy (TEM, 2014).

Forest biorefineries are an important factor in the change towards bioeconomy: they offer not only traditional wood-based products, such as paper or pulp, but also new products such as bioenergy and -chemicals (Hetemäki, 2010). Biorefineries are planned and have been built in several Finnish locations. For example the Metsä Fibre's so-called Äänekoski bioproduct mill, which claims to be " the first next-generation bioproduct mill in the world" with an annual pulp production capacity of 1.3 million tons, was inaugurated in 2017 (Metsä Fibre, 2018). Meanwhile, the world's largest softwood bioproduct mill is planned to be built in Kuopio (Finnpulp Oy, 2018). Bioeconomy clusters, such as new wood-processing biorefineries, can contribute to the economic growth of regional, rural areas by creating new jobs and affect even on national level as the output increases (Hetemäki, 2010; Wesseler & von Braun, 2017). Even though most emphasis is given to new high value added forest-based products, the existing, more traditional products such as pulp and paper are central to bioeconomy while the new products are still waiting for the actual implementation (Hurmekoski et al., 2018). Furthermore, it has been stated that the current level of R&D is lagging behind if the targets want to be achieved (Kniivilä et al., 2017). Additionally, the overall sustainability of the raw material and the acceptable level of use of forest resources is widely debated in both research (BIOS, 2018; Grassi et al., 2018; Kallio et al., 2018) and politics (Kjellber, 2019; Miltton Group, 2019).

Globally, urbanization is an ever-increasing phenomenon. It has been identified as one of the megatrends affecting societies and nations world-wide (see e.g. PwC, 2018; EY, 2016). Today 55% of the world's population lives in urban settings and by 2050 it is estimated that 68% of the world's population is urban (United Nations, 2018). Around 70% of Finnish people live in what is considered to be a urban setting (Tiihonen, 2016). According to estimates, in the future an increasing amount of jobs, trade, industry and working-age population will continue to concentrate in the Helsinki area and other major cities in Finland (von Bruun, Santtu & Kirvelä, 2009; MDI, 2019), hence increasing the amount of urban inhabitants further. Pätäri et al. (2016) identified megatrends such as population growth, urbanization and growing middle class as the greatest economic opportunities for the European pulp and paper industry. Along with the worldwide urbanization, also the importance of urban citizens as consumers increases (Dobbs et al., 2016). Green consumerism has emerged as consumers' answer to environmental concerns (Moisander, 2007). In the European Commission's updated bioeconomy strategy the importance of cities in implementing circular bioeconomy is highlighted (European Comission, 2018); urbanization creates possibilities for enhancing the economic and environmental aspects of bioeconomy. For example, wooden multistory buildings are one possibility to provide more environmentally friendly housing for urban dwellers (European Comission, 2018; Näyhä, 2019).

However, there are few studies, if even that, concentrating on the urban citizens' perceptions and acceptance of the forest-based bioeconomy concept in a quantitative manner. On the Finnish scale, the urban citizens' perceptions of forest-based bioeconomy have not previously been studied. The new forest-based bioproducts such as textiles will be a huge opportunity for forest industry to get a new foothold in the end-product markets, while urbanization creates new demand. Yet, in order to achieve these goals it must be known how urban citizens perceive and understand the forest-based bioeconomy as a whole. In order for the forest-based bioeconomy to have true legitimacy the overall perceptions – such as values, knowhow, interests and environmental entitlements – of citizens must be considered (Hansen et al., 2018; Mustalahti, 2018).

1.2 Aim of the study

The aim of this study is to increase understanding about urban citizens' perceptions concerning a forest-based bioeconomy. In order to achieve the aim, explorative quantitative survey data are collected and analyzed. The main research question is "what are the worldviews through which urban citizens understand the forest-based bioeconomy?" Furthermore, this thesis aims to provide insights into the question, "how do these worldviews affect the urban citizens' perceptions (acceptance, understanding, risk) of the forest-based bioeconomy?" These research questions are screened thought the Integrative Worldview Framework (De Witt et al., 2017), which provides a robust and novel theoretical frame for the study.

This thesis contributes to a Europe-wide research network to fulfill the research gap surrounding the topic. It is a part of the Perform Bioeconomy project, which is a collaboration of eight European research institutes aiming to understand the regional differences regarding perceptions and acceptance of forest-based bioeconomy. Replicable studies and comparable results give the chance to better understand the current state of European bioeconomy. The European Forestry Institute funds the project. (PerForm 2018)

The structure of the thesis is the following: chapter 2 presents the conceptual background and previous studies relevant to perceptions of forest-based bioeconomy to outline and explain the theoretical framework. In chapter 3 the data collection is explained. Chapter 4 presents the methods, chapter 5 the results and chapter 6 the discussion along with the proposals for future research. The thesis ends in a short conclusion in chapter 7.

2 Conceptual Background

2.1 Definition of bioeconomy

As explained in the first part of this thesis, bioeconomy refers to an economy that utilizes renewable natural resources as raw materials. The forest-based bioeconomy is given a general definition in a study by the European Forest Institute: "-- all economic activities that relate to forests and forest ecosystem services" (Winkel, 2017). Thus they want to include also the economic utilization of other ecosystem services. According to Wolfslehner et al. (2016, p. 5) the definition is the following: "The forest-based bioeconomy links the whole forest value chain from the management and use of natural resources to the delivery of products and services". Hagemann et al. (2016) define wood-based bioeconomy as a bio-based circular economy, which utilizes the hard parts of the stem and the products contain lignin. Figure 2 illustrates the several dimensions of forest-based bioeconomy.

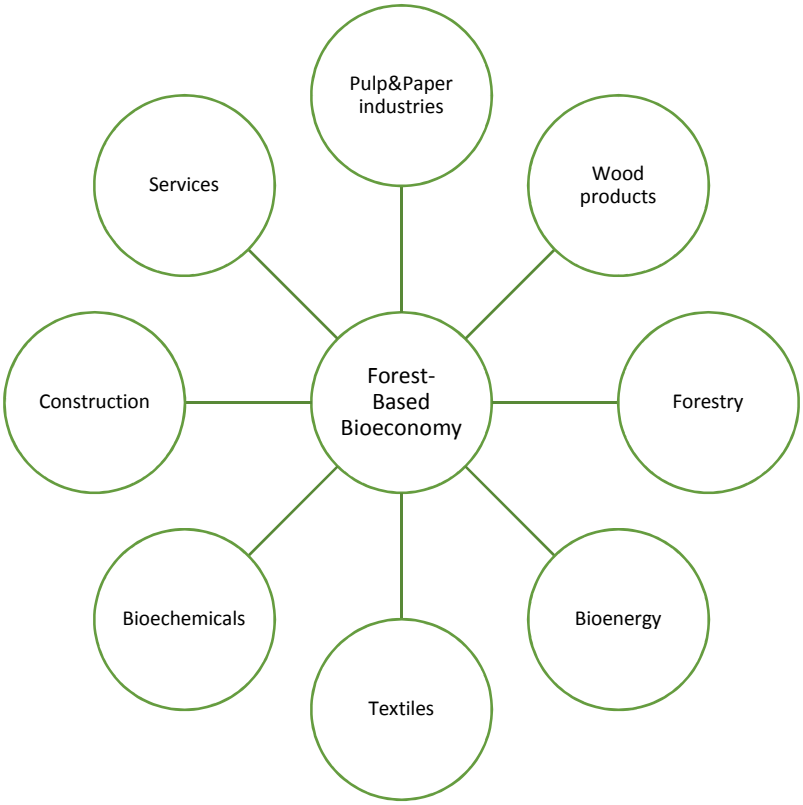

Figure 2. Dimensions of forest-based bioeconomy. Applied from Wolfslehner et al. (2016).

Pulp, paper and sawmilling industries are the traditional users and refiners of wood. New innovations in areas such as textiles, biochemicals, -plastics, -pharmaceuticals and construction are expected to become increasingly important for the forest and wood-based industries in the future (Scarlat et al., 2015; Wolfslehner et al., 2016, p. 3; Hurmekoski et al., 2018). From company perspective, the diversification of product portfolios is necessary as the traditional products of forest industries are sensitive to economic fluctuations. Also technological progress influences the markets of traditional forest products: for example the consumption of graphic paper decreases due to increasing digitalization (UNECE, 2018). In the future the traditional boundaries of forest sector versus other sectors will become increasingly blurred (Jonsson et al., 2017, p. 126–127); it is expected that forest industry firms will move along the value chain to other sectors, while firms from the other sectors move to forest industry (Hurmekoski et al., 2018).

Services in forest sector, and further in forest-based bioeconomy, are multidimensional. For example Näyhä et al. (2015) identified three types of services. Forest-related services are directly provided by forests and can be either market goods (e.g. timber, berries) or non-market goods (e.g. soil and biodiversity protection). Forestry-related services are mainly services for people, e.g. advising of forest owners, while industry-related services are mainly about new technological solutions for production. Additionally, services have both tangible and intangible dimensions. Currently intangibles such as recreation, tourism, non-wooden goods as well as tangibles like wooden pre-fabricated houses and intelligent packaging solutions are identified as service offerings in the forest sector (Pelli et al., 2017). In the emerging bioeconomy new niches may appear both in the industrial business-to-business chains and in small-scale entrepreneurship (Näyhä, 2019). For example, Ollikainen (2014) expects nature tourism to become a significant factor of bioeconomy in the future. However, as has been argued by Pelli et al. (2017), services have been given limited attention in the technologically oriented bioeconomy visions.

In the existing bioeconomy literature three different visions for bioeconomy can be identified: firstly, a bio-technology vision in which research, application and commercialization of bio-technology is emphasized; secondly, a bio-resource vision, which aims to create new value chains by tapping into upgrading and conversing biological

raw materials; and thirdly a bio-ecology vision, which promotes sustainable local use and optimization of raw materials (Bugge et al., 2016). Pfau et al. (2014) conducted a systematic literature review in order to identify how sustainability in bioeconomy is discussed and identified. Their findings point out that there is a lack of a common understanding of what makes bioeconomy sustainable: some scholars see sustainability in bioeconomy as the target, some say that sustainability is obvious in bioeconomy and some argue that using renewable resources instead of fossil ones inevitably leads to sustainability (Pfau et al., 2014). Nevertheless, simply being based on exploiting sustainable resources does not make bioeconomy sustainable (De Besi & McCormick, 2015). For example, competing use of biomass for food supply and biobased production is one topic that has sparked criticism towards potential bioeconomy practices, such as the "food versus fuel" debate (Lewandowski, 2015; Scarlat et al., 2015). Further, land-use and land-use change remains by large to be an unsolved question and has been predicted to become a limiting factor for bioeconomy's advancement (Hertel et al., 2013; Pfau et al., 2014). Sustainability should therefore be in the core of forest-based bioeconomy to ensure its continuance and public support (Wolfslehner et al., 2016, p. 5).

Bioeconomy as a term has also received criticism. Additionally other new conceptualizations of economy, such as the knowledge-based economy, have been alleged as being only buzzwords for policy-makers (Godin, 2006). Birch & Tyfield (2013) studied the conceptualizations of different "bio"-related formulations and claimed them to be vague. Additionally, they argued that many scholars have adopted a Marxian approach to bio-concepts and either ignored or failed to address the recent developments in political-economic analyzes, such as the changing ways of employment (Birch & Tyfield, 2013). Birner (in Lewandowski 2018, p. 24**)** defines this kind of criticism as fundamental critique. Further, Birner (2018) describes also other criticism towards bioeconomy, implicating to studies in which bioeconomy is seen as a possible promoter for land grabbing, a concept to promote the interests of big companies, and a possible means to cover unsustainability behind a bio-named concept as in greenwashing. Some stakeholders see bioeconomy as a new, trendy word and concept for ways that in fact have been in practice for a long time already (Näyhä, 2019); indeed, it has been mentioned that before the industrial revolution nearly all economies were based on biological resources (Scarlat et al., 2015). Additionally, new business opportunities do not

arise from concepts and definitions but from demand and a functioning business environment (Näyhä, 2019).

The importance of forest sector has not been fully realized in the EU and many national level bioeconomy strategies (Jonsson et al., 2017, p. 126). For example, the EU Bioeconomy strategy's definition of a bioeconomy is lacking the inclusion of services which are expected to become increasingly important in the future (Wolfslehner et al. 2016, p. 7). Further, Ollikainen (2014) criticizes the EU's Bioeconomy Action Plan (BAP), which is a plan to operationalize the Bioeconomy Strategy. According to Ollikainen (2014), the BAP does not realize the potential of forest-based sector and concentrates too much on agriculture. Additionally, he argues that the BAP fails to connect bioeconomy and sustainable green economy and growth.

To conclude, bioeconomy is all but one definition of a concept, which aims to produce economic growth by ecological solutions. Also words such as green economy, circular economy, knowledge based bioeconomy and bio-based economy come up when searching for literature. In a EU-report by Albrecht et al. (2010, p. 5) knowledge based bioeconomy is defined as "… sustainable supply of food, raw materials and fuels, together with recent scientific progress." Green economy has been identified as the main concept, as it takes into account all ecological processes and economic sectors; bioeconomy and circular economy complement it but are more resource oriented (Ollikainen, 2014; D'Amato et al., 2017).

2.2 Bioeconomy in Finland

Building more with wood is one of the aims of the Finnish Bioeconomy Strategy and wooden multistory construction (WMC) plays a major role in the emerging bioeconomy practices. According to Statistics Finland's definition multistory apartment buildings have minimum two apartments located on top of each other (Tilastokeskus, 2018). Building with wood can be more ecological; it is a renewable, lightweight material that also functions as a carbon sink during its lifetime (Puuinfo 2018). Additionally, building high-rise is a means of answering the urbanization as more people dwell in a limited area (Høibø et al., 2015). WMC buildings and their markets have been studied in e.g. Riala & Ilola (2014) and Toppinen et al. (2018). Riala & Ilola (2014) identified the barriers and opportunities for WMC in Finland by interviewing construction value

chain representatives. They found that the overall strong position of concrete building industry in Finland makes WMC promotion and implementation challenging. Wood was mentioned to be more expensive and materials less developed than concrete. Also poorer sound insulation and high maintenance cost were mentioned. On the possibility side technological innovations, such as cross-laminated timber, prefabrication, fast and quiet on-site construction phase and wellbeing of workers were identified. In Toppinen et al. (2018) the growing interest in sustainability was mentioned as a large possibility for wooden products and wood-building industries.

Bosman and Rotmans (2016) analyzed the transition towards bioeconomy in Finland. They found that there is no clear responsibility for the implementation of bioeconomy apart from the Ministry of Economics and Employment, which has taken up some ownership. Additionally, the importance of industry and societal partners in the final implementation of bioeconomy is emphasized, as without them participating there can be no real move towards the bioeconomy. Bosman and Rotmans (2016) identified four different pathways for Finnish bioeconomy: biofibers, bio-ICT, bio-built environment and bio-health. According to their analysis the Finnish bioeconomy transition is entering the takeoff phase. Mustalahti (2018) points out that here has been relatively little public, citizen-driven debate about the change towards forest-based bioeconomy and how it will affect the future living environment. Also other studies indicate that the Finnish forest-based bioeconomy network is rather limited to certain conventional actors such as research, government and industry (Korhonen et al., 2018). Kniivilä et al. (2017, p. 11) identified different obstacles for the development of Finnish bioeconomy: regulation, as in laws and policy instruments; attitudes from consumers, companies and government officials; lack of knowledge and education; economics, i.e. bioeconomy products being more expensive; and politics, i.e. lack of ambition for implementing bioeconomy solutions into practice. According to Antikainen et al. (2017, p. 103) the Finnish forest-based bioeconomy should not only be a bioeconomy, but pursue to be a forerunner in circular forest-based bioeconomy. Cooperation between and over different sectors, new innovations and start-ups are essential in creating a successful forest-based bioeconomy, as also the businesses believe there to be lots of untapped potential in forest and wood based resources (Näyhä, 2019).

In the Finnish Bioeconomy Strategy new services are mentioned "--- to have a significant and growing role in the new bioeconomy value chains": this refers to both industrial and business services value creation, tourism, as well as ecosystem services and natural resources (TEM, 2014). In Finland the so called Everyman's Right gives people an extensive access to forests as about 96% of the land area is considered to be accessible by it (Tuunanen & Tarasti, 2015). Wild berry picking has a long history in Finland and berries are considered one of the most important non-wood forest products (Salo 2015, p. 125). Berry and mushroom picking is closely related to other ecosystem services as well, as it provides people relaxation and a chance to enjoy nature. Approximately 2 million Finns pick berries and mushrooms (Salo 2015, p. 128) both for own use as well as for sales purposes. In 2011 a total of 44 million kilograms of berries was picked in Finland, which also has a significant monetary value (Vaara et al., 2013).

Forest owners are major contributors to the Finnish forest-based bioeconomy. Private forest owners supply approximately 80% of timber to industry purposes and own 60% of the productive forest land (Hänninen et al., 2011). The largest group of forest owners are pensioners (45%) followed by employees (30%) and farmers (16%) (Hänninen et al., 2011). Forest ownership is facing some comprehensive changes as the forest owners are becoming increasingly urban and older (Hänninen et al., 2011). This might have an impact on wood supply of the emerging forest-based bioeconomy.

2.3 Public perceptions

Earlier studies about perceptions and acceptance regarding bioeconomy and related products and services have had mixed results depending on the context and respondent groups. Table 1 highlights the main stakeholder studies relevant to this thesis.

Table 1. Main studies about public perceptions regarding the study context. N.B.: *=working paper

Context	Geographical scope	Research focus	Approach	Study
WMC buildings	USA (Pacific Northwest)	Public beliefs	Quantitative	Larasatie et al. (2018)
	Finland	Expert perceptions	Mixed methods	Toppinen et al. (2018)
	Finland	Expert perceptions	Qualitative	Riala & Ilola (2014)
Wood products	Finland	Consumer perceptions	Quantitative	Toppinen et al. (2013), Holopainen et al. (2014)
	Norway	Consumer preferences	Quantitative	Høibø et al. (2015)
Climate change mitigation	Canada (British Columbia)	Public perceptions	Quantitative	Peterson St-Laurent et al. (2018)
Bio-based products & innovations	Czech Republic, Denmark, Germany, Italy, Netherlands	Consumer perceptions	Qualitative	Sijtsema et al. (2016)
	Austria	Future-oriented individual perceptions	Qualitative	Ranacher et al. (2018)
	Austria, Finland, Germany, Slovenia	Public perceptions	Quantitative	Stern, Ranacher, et al. (2018)
	Finland	Consumer segments, attitudes, WTP	Quantitative	Haltia & Kniivilä (2017)*
Bioeconomy perceptions	Austria	Public perceptions	Mixed methods	Stern, Ploll, et al. (2018)
	Sweden	Stakeholder perceptions	Qualitative	Hodge et al. (2017)

In previous studies it has been claimed that the consumers' knowledge and awareness of bio-based products is still on a low level; correspondingly the willingness to pay for such products remains low as often the price level is higher than in traditional, fossil-

based products (Vandermeulen et al., 2012; Giurca & Späth, 2017). Giurca & Späth (2017) further link this to the lagging legitimacy of bio-based innovations. Thus, it is important to realize the perceptions and values of the public; if new, environmentally friendly technologies do not have public support it is difficult or even impossible to implement them (Spence & Pidgeon, 2009). Additionally, climate change is a distant phenomenon in space and time for a large part of the public (Spence & Pidgeon 2009; Peterson St-Laurent et al. 2018), which is one factor that explains the general opinions towards new environmental paradigms that fundamentally challenge the current ways of thinking. Trustworthiness among supply chain actors is essential for the bioeconomy to succeed, as it includes new technologies, changes in social structures and impacts living conditions (Asveld et al., 2015).

Consumer perceptions of the bio-based concept and a few corresponding products were studied via focus group discussions in five European countries (Czech Republic, Denmark, Germany, the Netherlands and Italy) (Sijtsema et al., 2016). According to the results the general consumers are not familiar with bio-based products, and the perceptions and feelings related to them are mixed and depend on the context. The bio-based concept in general was linked more with environmental issues than health and technology issues. An Austrian study also confirms that bioeconomy has mixed perceptions that differ between different groups (Stern, Ploll, et al., 2018). Students, pensioners, farmers and employees (N=456) were interviewed and two main visions were found: a technology & industry driven vision and another, regional environmentalism vision (Stern, Ploll, et al., 2018). Additionally, sustainable consumption behavior was identified as a positive contributor for positive bioeconomy expectations. The general perceptions regarding bioeconomy were positive but farmers had the most skepticism and fear for inequity brought by it (Stern, Ploll, et al., 2018). As farmers are major providers of raw materials, their views should be paid special attention to in the development of bioeconomy (Stern, Ploll, et al., 2018). Consumers' willingness to pay for bio-based products has been classified as one of the factors affecting the wood-based bioeconomy's future; if there is no demand and willingness to pay for bio-based products there is also no interest in investing in bio-based production and innovations (Hagemann et al., 2016). Easily available information is in a crucial role in creating demand for bio-based products (Hagemann et al., 2016).

Ranacher et al. (2018) studied the perceptions of potential future opinion leaders regarding four wood-based innovations in Austria: wooden multistory timber construction, biorefineries, natural fiber reinforced composites and nanocellulose. Wood-based innovations are expected to be major contributors to bioeconomy in the future but in order to gain solid ground in the markets, the public needs to accept these innovations (Ranacher et al., 2018). Ranacher et al. (2018) argue that "the societal perception of wood-based innovations is considered key for the creation and acceptance of bioeconomy strategies." Also Stern et al. (2018) studied the perceptions regarding innovative bioeconomy products and services. Both studies came to the conclusion that the public demands more information about the economic and environmental impacts of biobased products. Hodge et al. (2017) studied the perceptions of forest-based bioeconomy of three Swedish forest stakeholder groups (forest industry, forest owners and ENGOs) in a qualitative manner. In conclusion the perceptions were positive from all fields. Bioeconomy was mentioned to be a "response to global issues of resource depletion and CO2 emissions" (Hodge et al., 2017). Anyhow, economic development was seen as the primary motivation for developing the forest-based bioeconomy further as it provides possibilities for new markets and products. Public's separation from nature was connected with growing urbanization by the ENGOs and forest owners and seen as a risk for bioeconomy, as they believed it to decrease the public's experiences and knowledge of sustainable nature and forest management (Hodge et al., 2017). According to Ranacher et al. (2018) the wood-based innovations can be perceived very differently between different consumer groups. Those already involved in forest sector, or acquinted with the forest-based products in question, tend to have more positive beliefs and prefer different aspects than those who are not involved in the sector (see e.g. Larasatie et al. 2018; Stern et al. 2018).

Wooden multistory construction (WMC) plays a major role in the emerging bioeconomy practices. WMC buildings, which are one form of forest-based bioeconomy innovations, and the public perceptions regarding them have been studied to some extent in the past few years. Larasatie et al. (2018) studied the US Pacific Northwest citizens' beliefs connected to WMC's via a quantitative online survey. In their study most of the respondents identified WMC's as having a greater risk of fire, needing more upkeep and maintenance and not being as long-lasting as buildings made of steel or con-

crete. WMC's were additionally seen as possible contributors of deforestation. Nonetheless, the general opinion of WMC's visual pleasing, healthy living environment and environmental friendliness was positive (Larasatie et al., 2018). In research, wood has been proven to possess health-promoting qualities. It is antibacterial; it levels the changes in indoor temperature and humidity; it improves the acoustics; and it creates overall positive psychological effects (Muilu-Mäkelä et al., 2014; Vainio-Kaila, 2017). Høibø et al. (2015) studied the Oslo area residents' building material preferences and found out that in general younger people are more inclined to perceiving wood as favorable building material. Additionally, they argue that "the preference for wood products in the built environment increases with increasing concern about environmental impacts" (Høibø et al., 2015). In order for the WMC to become a credible choice, the construction markets need a change; both more competition and more co-operation is needed whilst gaining the interest of the whole value chain, from engineers to residents (Hurmekoski et al., 2015).

As forests play a central role in mitigating climate change also the publics' acceptance of different forest management customs is an important factor to consider in the context of forest-based bioeconomy. It was studied in Canada's British Columbia via a web-based survey, which presented eight different climate change mitigation strategies for forest management (Peterson St-Laurent et al., 2018). The most important target of forest management was impact on biodiversity. According to the results, scientists and professional foresters were most trusted in providing information about climate change. Ranacher et al. (2017) conducted a survey related to the public perceptions of forest ecosystem services in Finland, Austria, Germany and Slovenia. Results indicate that forests' role in providing different ecosystem services is well recognized, regulating services (i.e. air and water quality, erosion) being most valued and provisioning ecosystem services (i.e. food, chemicals) less valued. Perceptions about climate-change risks form on a complex basis of knowledge and individual and collective beliefs (Kahan et al., 2012).

Industrial investments, such as biorefineries, are important for the bioeconomy; in 2030, as much as 40% of the pulp and paper industries turnover is expected to originate from new products (Toppinen et al., 2017). As a company is investing in biobased production the risks should be identified already in the planning phase. From industry

point of view, the risks in investing in bioeconomy production are versatile: major risks come from markets, technology, finance, regulation and supply chain (Assis et al., 2017). The role of consumers is significant in market and supply chain related risks. If the biobased product simply competes with a traditional petrol-based product its price is volatile and dependent of that of petrol's. If the biobased product offers unique applications and value-added they are less impacted by the petrol price level changes. The final product distribution channels should be secured in order to ensure the flow of products to customers. (Assis et al., 2017)

In a broader perspective, Finnish consumers' attitudes related to bioeconomy have been studied in a nationwide survey (Haltia & Kniivilä, 2017; Kniivilä et al., 2017). Haltia and Kniivilä (2017) studied in their working paper the Finnish consumers' attitudes towards and willingness to pay for bioeconomy products, and identified three different consumer segments based on their preferences: the environmentally conscious (*ympäristötietoiset*), emphasizers of domestic goods and economy (*kotimaisuutta ja taloutta painottavat*), and price-conscious and anti-environmentalists *(hintatietoiset ja ympäristövastaiset).* As a conclusion they found that most of Finns have positive attitudes towards biobased and environmentally friendly products. They state that the most influencing factors for pro-environmental decisions are price, availability and the existing behavioral patterns. Further, they discuss how tax reliefs and increased public procurement on biobased products as well as nudging methods could affect the demand for bioproducts positively (Haltia & Kniivilä 2017; Kniivilä et al. 2017). Thus, the results are in line with e.g. Hagemann et al. (2016), considering the willingness to pay, which is identified as a central aspect of bio-based products' demand (Hagemann et al., 2016). Riala & Ilola (2014) mention that being environmentally friendly alone does not mean an increased willingness to pay more for construction.

Finnish consumers' values and perceptions of wooden products have been studied by Toppinen et al. (2013) and Holopainen et al. (2014). Both used exit-survey data collected from home building material centers. In Toppinen et al. (2013) the concentration was on the perceived environmental and social sustainability of wood products, and two factors were found: 1) general environmental and social sustainability, and 2) specific social sustainability. A similar type of perspective was in Holopainen et al. (2014)

which studied the dimensionality of sustainability in consumers perceived value regarding wooden products. They found four factors of importance: 1) information and product origin, 2) consumer activity, 3) product image and 4) quality. In both studies women and older people gave more emphasis on the environmentally-focused factors.

Bioenergy is one of the central areas of bioeconomy. The social acceptance of renewable energy in Finland was studied by Moula et al. (2013) via a questionnaire survey conducted in the Helsinki region. According to their results the majority of people think it is important to develop renewable energy technologies, but the main responsibility for implementing the use of renewable energies is on the public sector. Wüstenhagen et al. (2007) define three different dimensions that are related to the acceptability of renewable energy: socio-political, community and market acceptance.

Environmentalism and pro-environmental behavior from various perspectives have been studied in environmental psychology (Spence et al., 2008). Kollmuss & Agyeman (2002) studied the different frameworks explaining the gap between environmental knowledge and pro-environmental behavior. According to them, the factors affecting pro-environmental behavior are so versatile and complex that compiling them all is most likely not possible. Anyhow, they believe that one of the most important aspects affecting the pro-environmental behavior is old behavior patterns. New pro-environmental behavior must be practiced long enough that it becomes a habit to change the old behavior patterns (Kollmuss & Agyeman, 2002). Also the so-called green gap, or attitude-behavior gap, should be considered: it has been shown that people tend to overestimate their own willingness to pay for sustainable products (Moser, 2015). Personal beliefs and benefits seem to have the most importance when making an environmentally friendly purchase decision (Pfau et al. 2017, p. 5).

2.4 Integrative Worldview Framework

The changes in global perceptions, values and attitudes have been studied in the World Values Surveys since 1981 (Inglehart 2018, p. 5). Based on the studies the Inglehart-Welzel cultural map defining a country's location on a two-dimensional map was formed: it illustrates how a country locates on both traditional vs. secular-rational values and survival vs. self-expression values (figure 3). Finland, along with the other Nordic countries, has been shown to have strong emphasis on the self-expression and

secular-rational values, which can be assumed to show in the results of this study accordingly. High self-expression values tend to mean also a higher emphasis on environmental values within a society whilst secular-rational values incline less importance on religion, tradition and authority (Inglehart 2018, p. 36-37; World Values Survey 2018). As the post materialist values become predominant the concern for environmental risks increases (Inglehart 2000).

Another way to frame the risk perceptions of a society is the Cultural Theory or cultural theory of risk, which works on a four-dimensional axis and emphasizes the importance of the surrounding society in an individual's values and worldview (Hulme 2009, pp. 185-186). Nevertheless both of these frameworks have gained criticism, Inglehart's for being purely based on economic values and Cultural Theory for being too simple (Hulme 2009, p. 187, 191). Cultural Cognition Theory (CCT) is a conception of Cultural Theory (Kahan, 2012, p. 726) and builds on the expectation that people have a tendency "--- to base their factual beliefs about the risks and benefits of a putatively dangerous activity on their cultural appraisals of these activities" (Kahan et al., 2009).

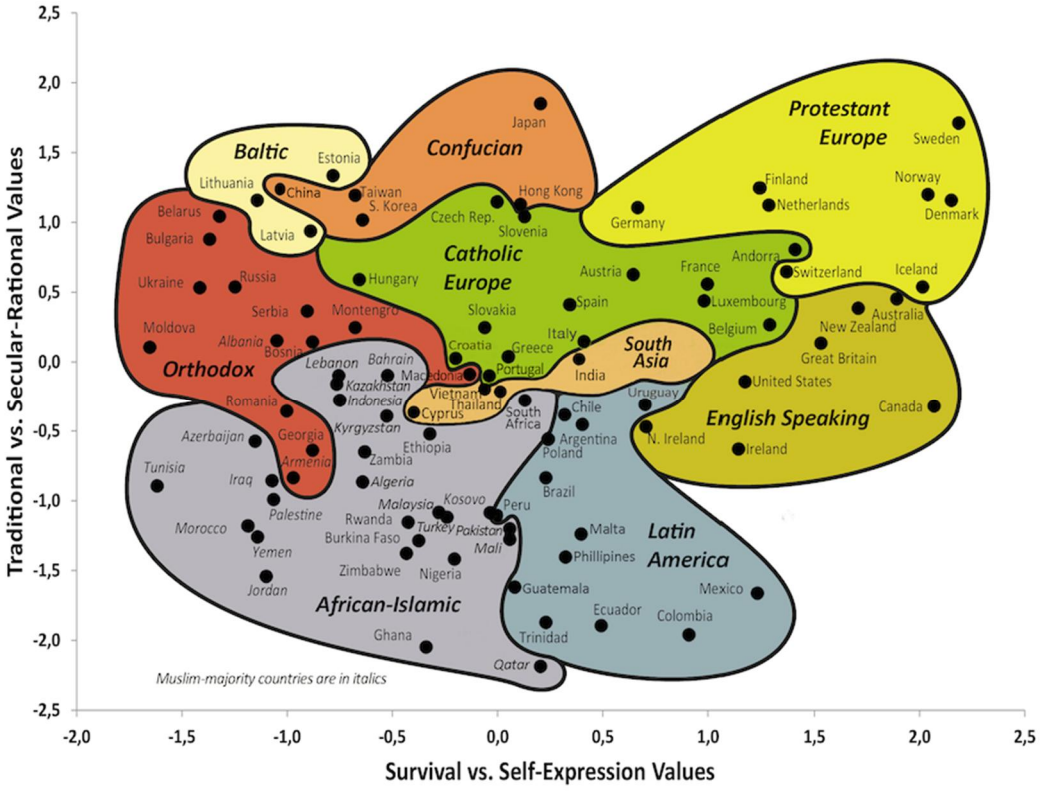

Figure 3. Cultural map - WVS wave 6 (2010-2014) (Inglehart et al. 2014).

Integrative Worldview Framework (IWF) was developed by De Witt et al. (2016; 2017; Hedlund-de Witt et al. 2014) as a response to CCT in order to take into account the more complex factors of public perceptions, such as understanding of reality, divine and nature; additionally, CCT was seen to be too concentrated in the risk perception. According to Hedlund-de Witt (2013) the definition of a worldview is the following: "Worldviews are inescapable, overarching systems of meaning and meaning making that to a substantial extent inform how humans interpret, enact, and co-create reality." The IWF consist of five aspects – ontology, epistemology, axiology, anthropology and societal vision – and differentiates four ideal-typical worldviews: traditional, modern, postmodern, and integrative (figure 4). The use of IWF as a theoretical framework in this study is justified as it provides a more interdisciplinary approach and helps in understanding the underlying worldviews on which also the perceptions of the urban citizens are formed. Additionally, in this study the perceptions are considered as comprehensive opinion - understanding - belief. De Witt (2017) has previously used the IWF to study e.g. how worldviews and an individual's lifestyle choices interact with sustainability (Hedlund-de Witt et al., 2014; De Witt et al., 2017).

Of the IWF's five aspects ontology considers the nature of reality and answers questions about the creation of the universe and nature's essence. Ontology is divide-oriented and aims to answer the question what is real. Epistemology considers the knowledge of reality through questions such as "how can we know what is real" whereas axiology takes into consideration the morals, ethics and esthetic values of a good life. Anthropology considers the existence and nature of human being. Societal vision considers the organization and fundamental questions of societies. (De Witt et al., 2017)

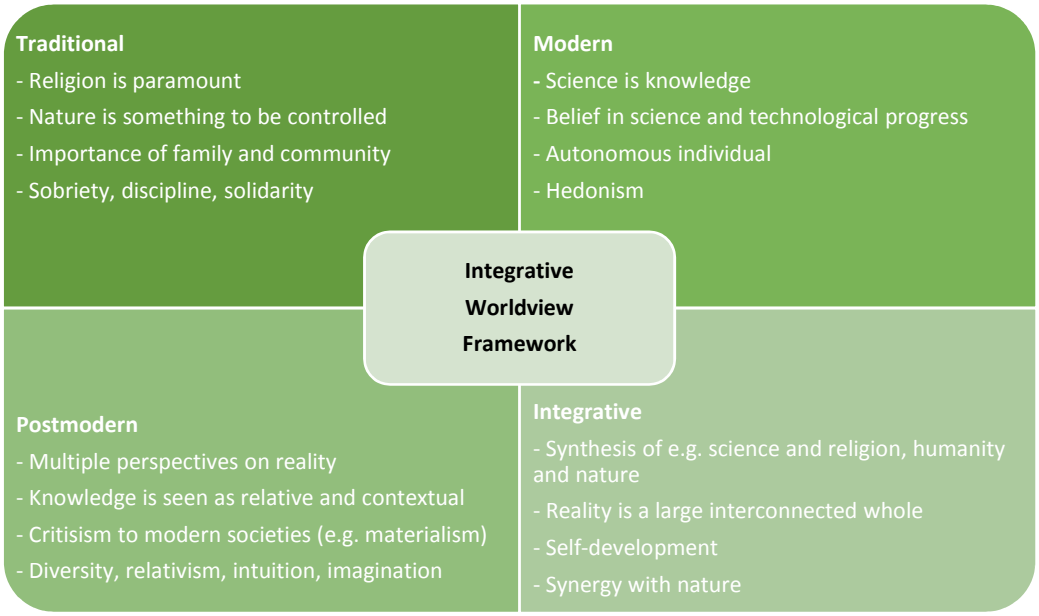

Figure 4. Four ideal-typical worldviews of the IWF. Applied from De Witt et al. (2016, 2017).

The ideal-typical worldviews are built upon these five aspects, and work as analytical tools to help analyze the abovementioned aspects. The traditional worldview has religious or metaphysical approach; religious authorities are respected. Nature is seen as something that should be controlled and managed by man. Traditions, discipline, sobriety and such are valued. The modern worldview trusts in science and technology. They are believed to provide the knowledge, reality and way to progress. Individual, hedonistic values are important. In the postmodern worldview multiple perspectives on reality are accepted. Knowledge is seen as something of relativity and context, and science's ability to provide knowledge is questioned. Criticism toward modern societies is expressed. Imagination, diversity, relativism, intuition and such are among the valued traits. Integrative worldview is a newer concept and still more speculative. It offers a holistic perspective on the world: reality is connected to nature, spiritualism and connects on a deeper level, and is suggested to become of more importance in the future bioeconomy discussions. It is expected that the integrative worldview will not be as clearly represented in the results. (De Witt et al., 2016, 2017)

The IWF has not previously, to the author's present knowledge, been applied to this kind of study, thus making it a new and interesting approach. This study uses IWF as a conceptual support to generate statements that can be used to assess those

worldviews that are associated with the forest-based bioeconomy. It is expected that the results of this study will not fall straight into the categories provided in the IWF; hence, this study also aims to contribute to the development of the framework.

3 Data

3.1 Survey

The data of the study were collected by a quantitative survey (appendix 1 and 2). The target was to collect 200 responses in minimum, which is considered a sufficient sample size for statistical analysis (Metsämuuronen, 2011, p. 635). In total, 206 answers were gathered. Roughly the same number has been used in other similar studies; N=208 in Holopainen et al. (2014) and N=227 in Toppinen et al. (2013). The survey form was first based on the survey of Larasatie et al. (2018), which explored the perceptions of the US Pacific Northwest public regarding WMC buildings. Later on the survey was further improved based on the studies by Peterson St-Laurent et al. (2018), which studied British Columbia's public perceptions of climate change mitigation, and De Witt et al. (2017), which gave the theoretical framework for the study. The questionnaire was reviewed and commented on by the other research groups in the Perform project before it was actually implemented. Additionally, the survey was piloted during the development phase with seven random respondents before the implementation in order to detect the possible inconsistencies and other problems. The aim was to formulate concrete and understandable claims to exclude the risk of confusion as much as possible. Also the length of the survey was controlled to keep it no longer than one page (A4).

Exploratory approach was chosen due to the novel theme of the study. Exploratory research is conducted when there is little or no knowledge about the topic (Stebbins, 2001, p. 6). Additionally, the research works on primary data, because a similar survey had not previously been made. Primary data is original data collected by the researcher for a specific cause; therefore there should be no fear of bias regarding the aim of study and collected data (Persaud, 2012). In primary data collection the researcher has total control over the data collection process whereas in secondary data the researcher must rely on the previous work of others (Persaud, 2012). In this specific study the explorative quantitative approach is applied, which provides understanding to the underlying structure within the data (Kraska, 2012). The survey form had a 6-level Likert scale with ranges from 1 ("strongly disagree") to 6 ("strongly agree") with no option for "do not know" as this study is not about knowledge as such, but about perceptions; in this survey, perception means the respondent's comprehensive opinion, understanding and

belief of the claim. 34 statements in total were presented in the questionnaire along with the respondent's background information (age, gender, ownership of land or forest, living area). In this study, people were given three options in the survey to choose as their current area of residence: urban, suburban and rural.

A short explanation of the Perform Bioeconomy project was given to respondent in the beginning of the survey. The survey consists of three sections: first 10 claims of WMC buildings, second 5 claims of forest carbon storage and third 19 claims of forest-based bioeconomy. The first section has questions based on Larasatie et al. (2018), e.g. about maintenance requirements of WMC buildings and their posed fire risks. The second and third section are modified from Peterson St-Laurent et al. (2018). Additionally, the third section is applied from the Integrative Worldview Framework: claims 16 and 32-34 on epistemology regarding knowledge and trust; claims 17-21 on axiology regarding economic aspects; and claims 22-27 on societal vision about e.g. risks and regulation. Additionally, claims 28-31 were based on an earlier study (Dunlap et al., 2000) and screened through the anthropology-aspect of the IWF. In the context of this thesis ontology-aspect of the IWF is excluded for being considered too divinity-focused, and not hold much value in secular-rational European societies such as Finland (figure 3).

The questionnaire ends in the respondent's socio-demographic background information (age, gender, forest/land ownership, residence area) and a short GDPR (General Data Protection Regulation) statement in which the respondent agrees to give the provided answers for research processing. However, the survey was conducted as anonymous as no other personal details were collected and the respondents were totally random based on their willingness to take part in the survey. This survey thus applies randomized approached, which helps to control the possible bias within respondent group and increases the reliability of the data (Metsämuuronen, 2011, p. 61; Kraska, 2012).

3.2 Data collection

The data were collected in Helsinki city center December 3rd 2018 – January 26th 2019. The collection was conducted during approximately 23 days, both during workdays and weekends. City center area was chosen as the survey was intended to target

urban people. This should improve the validity of the data, make it more representative of urban citizens and decrease the bias when compared to e.g. mail surveys.

The survey was conducted during daytime in Narinkkatori, Lasipalatsinaukio and Kansalaistori squares, which are central and busy pedestrian areas in Helsinki. Survey was collected in person by the researcher with traditional pen-and-paper technique, as it is easy and efficient to implement. Additionally, this decreases the risk of a major bias in the results as the respondents could ask the researcher for clarification if they felt the claims were not understandable. People were approached randomly by greeting and asking if they had a few minutes for a university study. If they agreed, the reason for the study and the survey form was explained to them. It was emphasized that the survey was not intended to measure knowledge, but the individual perceptions. Additionally, after the survey had been filled the respondents were asked verbally how they felt it was and if they had some questions or comments concerning the topic. Most people had positive views regarding the survey, although some felt the claims were too difficult and the theme was unfamiliar which made it more difficult to answer. Additionally many gave feedback for the lack of "no opinion/neutral" on the answer scale.

On average it took 5-10 minutes to fulfill the survey. Although no data were gathered about the response rate, most of those who stopped to hear about the research did stay to answer. The data were transferred manually to digital form (Excel-sheet) after the collection.

3.3 Validity and reliability

Risks are involved in data collection. Getting respondents by random can be challenging. Non-differentiation in ratings or so called straightlining – where the respondent chooses the same answer thorough the set of questions – is a risk to data quality (Schonlau & Toepoel, 2015), although these were not detected to be a problem in the data. People who do participate might be already more interested and involved in forestry or other bioeconomy-related field, which would presumably give too positive opinions.

Also other disadvantages lie with the data collection technique applied here. As the data were collected in Helsinki area it should not be interpreted as representative of Finnish urban citizens as such: there might be regional disparities with other cities and towns. The nonresponse rate is practically impossible to measure. Some responses were incorrectly filled (as in the answer was missing, two answers were marked for the same claim or answer was marked in the middle of the scale). In some of the survey claims two different objectives were given (such as claim 2 " … are faster *and* cheaper to build than steel or concrete buildings") although claims should only have one dimension (Metsämuuronen, 2011, p. 114), and this might have made answering more difficult for the respondents.

Although the sample size (N=206) is considered convenient for factor analysis, it should have been significantly higher for the crosstabulations in order to fulfil all of the Pearson's chi-square conditions. Factor analysis was however the main method intended for this specific data sample, and crosstabulations were used only for gaining a better insight into the data. Thus, the sample size can be considered satisfactory. To conclude, as this is an exploratory study the results should be considered as indicative only and further studies need to be done for generalization.

4 Methods

Exploratory factor analysis was used to build a more profound theory of the phenomenon. In addition basic descriptive statistics such as frequencies, means, and crosstabulations are presented. SPSS 25 Programme was used for statistical analysis. The statistical analyses are designed to answer the main research questions of the study: "what are the worldviews through which urban citizens understand the forest-based bioeconomy" and further "how do these worldviews affect the urban citizens' perceptions of the forest-based bioeconomy."

In Ketokivi (2015, p. 194), factor analysis is explained as a special case of structural equation model. Structural equation model is statistics' answer for statistical questioning of complicated theoretical models: usually the factor is a theoretical concept and measures are the variables in data (figure 5) (Ketokivi, 2015, p. 199, 298). Paloniemi & Vainio (2014, p. 57-63**)** explain the use of structural equation models in the context of Finnish social scientific environment studies. People tend to express their attitudes towards environmental matters as either positive or negative. Thus, environmental attitudes can be measured by presenting claims, which the respondents answer (Paloniemi & Vainio 2014, p. 53), as has been done in this thesis. According to Paloniemi & Vainio (2014, p. 58) structural equation models are well suited for studying complex theoretical phenomena, such as values, attitudes and acceptance.

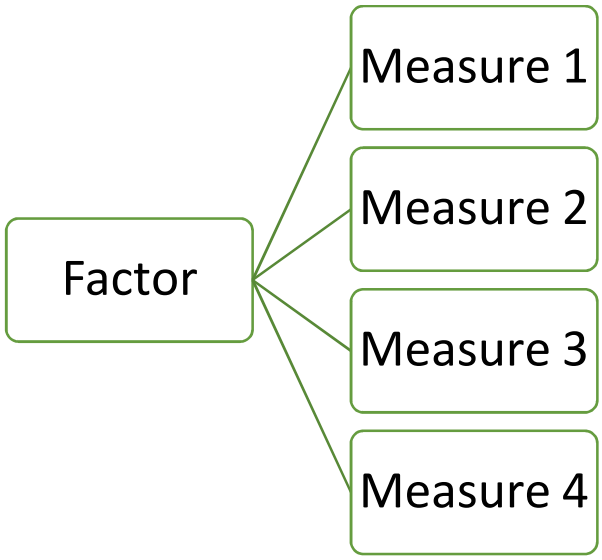

Figure 5. Factor analysis model simplified. Applied from Ketokivi (2015, p. 298).

Exploratory factor analysis is especially useful in a situation where there are no strong presuppositions or hypotheses associated with the data – vice versa, the researcher seeks for a model within the data (Ketokivi, 2015, p. 196). Factor analysis is especially useful when the observed data needs to be summarized and the number of variables reduced (Tabachnick & Fidell, 2014, p. 660). Initially it helps to better understand the relationships and patterns of data (Yong & Pearce, 2013).

Exploratory factor analysis has several steps (Yong & Pearce, 2013). In this study, first the countryside-dwellers were removed from the data along with detected outliers. Then an explorative factor analysis was conducted (Maximum likelihood estimation with Varimax-rotation). Varimax-rotation is recommended in the initial exploratory phase (Yong & Pearce, 2013). Eigenvalues more than 1 was used as a primary guide for the factor dimensions. The Kaiser-Melkin-Olkin (KMO) measure test and Bartlett's test of sphericity were conducted to see whether the sample is suited for factor analysis. Additionally, a reliability analysis was conducted in the end. Factors are named and interpreted after the rotations based on the variables that the factor reflects with (Metsämuuronen, 2011, p. 671).

In addition to factor analysis also basic statistics are used to clarify and describe the data. Crosstabulations are especially useful in demonstrating the interrelationships between two different variables (Metsämuuronen, 2011, p. 357). Pearson's Chi-Square tests ($\chi 2$) are done to test the statistical significance of the crosstabulations tables.

4.1 Summary of the data

The total number of answers was 206, which was more than the predetermined minimum amount. Few missing values were replaced with the series means in SPSS before the analysis.

The majority of respondent lived in an urban area (n=182, 88%) and 20 (9.7%) in a suburb (table 2). Four respondents lived in countryside. The suburban-area respondents are presented in the same respondent group as urbans for statistical purposes. Ad-

ditionally, as this survey is conducted in several different countries in which the definitions for urban and suburban may alter, the urban and suburban are counted as the same.

117 (56.8%) of all respondents were women and 86 (41.7%) were men, while three respondents identified as non-binary gender (table 3). Women form the majority of Helsinki area residents (Mäki & Vuori, 2017), and thus the larger share of women respondents was expected and is acceptable in also these results. In total 40 (19%) of respondents owned more than one hectare of land or forest, which is more than the Finnish average (table 4). Approximately 57% of the forest owners were men. Of the forest/land owners 37 lived in urban or suburban areas. The age of respondents ranged from 16 at youngest to 83 at oldest with mean age being 38 years (figure 6). The younger age cohorts are strongly represented in the data; nearly 45% of the urban/suburban respondents were less than 30 years of age. This is acceptable considering that Helsinki area has a younger population than Finland on average (Mäki & Vuori, 2017, p. 10) but needs to be acknowledged in the analysis.

Table 2. Respondents' area of residence.

	n	%
Rural	4	1.94
Urban/suburban	202	98.06
Total	206	100

Table 3. Gender distribution of respondents.

	n	%
Female	117	56.80
Male	86	41.75
Other	3	1.46
Total	206	100

Table 4. Forest/land owners.

	n	%
No	166	80.58
Yes	40	19.42
Total	206	100

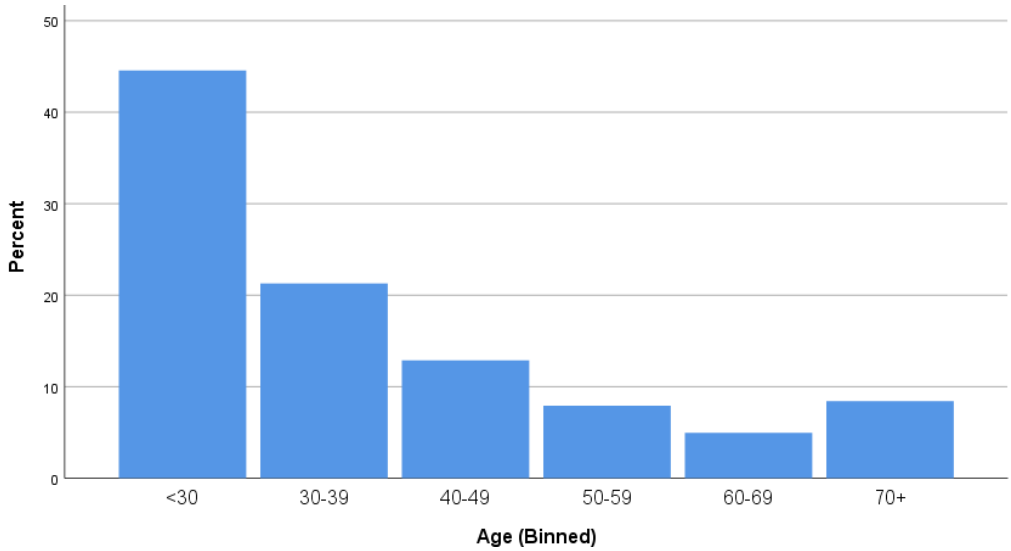

Figure 6. Urban/suburban respondent age distribution (N=202).

5 Results

In the following results, only the respondents who identified as urban or suburban dwellers were taken into the calculations.

Overall, respondents had positive perceptions of bioeconomy, and the perceived knowledge and familiarity of the topic among Finnish urban citizens seems to be relatively high. Table 5 describes how the majority of respondents perceived themselves to be familiar with both wooden multistory buildings (91.1%) and forest carbon sequestration (82.2%), when answers ranging from 1 (strongly disagree) to 3 (mildly disagree) were coded as "no" and answers from 4 (mildly agree) to 6 (strongly agree) were coded as "yes." Concerning the perceived knowledge of forest-based bioeconomy, the majority felt that they know its meaning (58.9%).

Table 5. Table of responses on familiarity and knowledge (1-3=no, 4-6=yes) (N=202).

	No		Yes	
	n	%	n	%
I am familiar with wooden multistory buildings	18	8.9	184	91.1
I am familiar with how forests store carbon	36	17.8	166	82.2
I know the meaning of forest-based bioeconomy	83	41.1	119	58.9

The descriptive statistics of the urban and suburban respondents are presented with mean and standard deviation in table 6. The highest overall means are on the claims "Use of fossil fuels and non-renewable materials must be reduced as soon as possible" (mean 5.12) and "Despite our special abilities, humans are still subject to laws of nature" (mean 5.03), which means that respondents tended to agree with these claims. Respectively, the lowest means are on the claims "The risks of forest-based bioeconomy are greater than its benefits" (mean 2.61) and "Humans have the right to modify the natural environment to suit their needs" (mean 2.66). Thus, this indicates people tended to disagree with these claims. When looking at the normality distribution, it is evident that these variables are however not normally distributed but inclined to the direction of the mean value.

The highest standard deviation was on “I am familiar with how forests store carbon” (SD 1.35) followed by “I know the meaning of forest-based bioeconomy” and “(WMC buildings) Do contribute to global deforestation and biodiversity loss” (SD both 1.33). This would indicate that the respondents’ perceived knowledge of these topics varies strongly.

Slightly positive perceptions were identified with the first part of the survey that dealt with multistory buildings with a mostly wooden frame. WMC buildings were perceived to be healthier to live in and less harmful to climate than steel or concrete buildings. In contrast, they were seen as more fire-prone than those made of steel or concrete. The second part of the survey, about storing carbon in forests, indicates that Finnish urban citizens have positive views of the current Finnish forest management practices. Support for land/forest owners in forest management and monetary compensation for carbon storage in forests also received high agreement.

Regarding trust in different actors, researchers and experts were trusted the most as per the highest mean value (4.69) and this claim also had the lowest standard deviation of the three variables (SD 0.97). Government officials were trusted the least (mean 3.65, SD 1.21) whilst environmental and civic organizations placed in between (mean 4.02, SD 1.10).

Table 6. Mean and standard deviation of the urban/suburban respondent answers (N=202) (1=strongly disagree, 6=strongly agree).

	Mean	SD
I am familiar with wooden multistory buildings	4.85	1.09
Are faster and cheaper to build than steel or concrete ones	3.75	1.00
Do not last as long as steel or concrete buildings	3.00	1.26
Need more repairs and maintenance than steel or concrete buildings	3.35	1.15
Need less insulation than steel or concrete buildings	3.62	1.11
Are healthier to live in than steel or concrete buildings	4.59	1.09
Have a higher risk of fire than steel or concrete buildings	4.02	1.30
Are less harmful to climate than steel or concrete buildings	4.60	1.14
Do contribute to global deforestation and biodiversity loss	3.37	1.33
Do generate income and well-being to more people than steel or concrete buildings	3.96	1.04
I am familiar with how forests store carbon	4.61	1.35
Managed forests have great potential to reduce carbon emissions	4.98	0.97
How forests are being managed can threaten carbon stocks in forests	3.82	1.32
Land/forest owners need support to maintain and manage forests	4.85	0.93
Land/forest owners must be compensated monetarily for storing carbon in forests	4.34	1.16
I know the meaning of forest-based bioeconomy	3.68	1.33
Forest-based bioeconomy decreases our dependency on oil and fossil fuels	4.64	0.92
Forest-based bioeconomy increases our economic self-sufficiency	4.82	0.83
Forest-based bioeconomy generates new jobs and well-being in rural areas	4.85	0.85
Forest-based bioeconomy mainly benefits large companies and their shareholders	3.01	0.98
Forest-based bioeconomy products should be of domestic origin to be more sustainable	4.01	1.16
Agriculture-based bioeconomy is more important for society than forest-based bioeconomy	3.18	0.78
The risks of forest-based bioeconomy are greater than its benefits	2.61	0.86
The risks of forest-based bioeconomy must be understood before we fully embark on it	4.43	0.99
All different views must be seriously considered when forest-based bioeconomy develops	4.32	1.03
Use of fossil fuels and non-renewable materials must be reduced as soon as possible	5.12	1.14
Environmental regulation limits overall economic development and growth	3.25	1.19
Humans will be able to solve environmental problems when technology develops	4.50	1.07
Despite our special abilities, humans are still subject to laws of nature	5.03	1.06
Humans have the right to modify the natural environment to suit their needs	2.66	1.17
The balance of nature is very delicate and easily upset	4.95	1.03
I trust information on forest-based bioeconomy from government officials	3.65	1.21
I trust information on forest-based bioeconomy from researchers and experts	4.69	0.97
I trust information on forest-based bioeconomy from environmental and civic organizations	4.02	1.10

5.1 Crosstabulations

Crosstabulations help us to illustrate how two or more different variables correlate (Metsämuuronen, 2011, p. 563). The crosstabulations were calculated according to the respondents' background information: gender and ownership of forest/land area. Results that provided a statistically significant result (Pearson chi-square less than 0.05) are presented. Additionally, some results that did not meet the statistically significant assumption are presented to give a broader explanation of the overall results. In the crosstabulations a larger sample size would have been needed to meet the third assumption of the Pearson chi-square test (expected counts), and thus these results need to be interpreted with caution. The results were nevertheless included in this thesis, as they indicate a correlation of the two variables and provide a deeper sight into the data albeit missing stronger statistical support.

5.1.1 Gender

Gender showed little statistical significance in this survey. Of the 34 variables, only 4 (12%) differed by gender ($p<0.05$). The majority of women agreed with claim 13, "How forests are being managed can threaten carbon stocks in forests", while male answers were distributed more evenly on the whole scale (figure 7). This might mean that women tend to have more skepticism towards current forest management practices.

For claim 18, "Forest-based bioeconomy increases our economic self-sufficiency", gender had statistical significance ($p=0.000$) (figure 8). Men had stronger perceptions regarding forest-based bioeconomy's risks and benefits. 53% of women answered "mildly disagree" which indicates a more cautious approach to the claim. As for claim 23, "The risks of forest-based bioeconomy are greater than its benefits", ($p=0{,}018$) (figure 9) and claim 33, "I trust information on forest-based bioeconomy from researchers and experts", gender showed statistical significance (figure 10). Women showed slightly more trust in researchers and experts than men did.

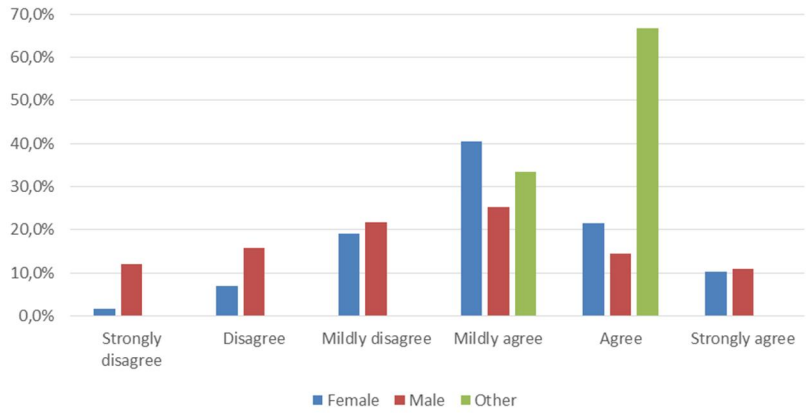

Figure 7. How forests are being managed can threaten carbon stocks in forests * Gender. Pearson Chi-Square: 0.015. 7 cells (38.9%) have expected count less than 5. The minimum expected count is .18.

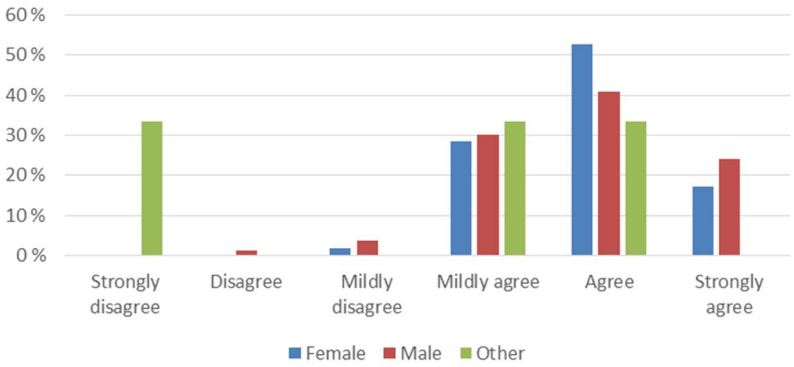

Figure 8. Forest-based bioeconomy increases our economic self-sufficiency * Gender. Pearson Chi-Square: 0.000. 12 cells (66.7%) have expected count less than 5. The minimum expected count is .01.

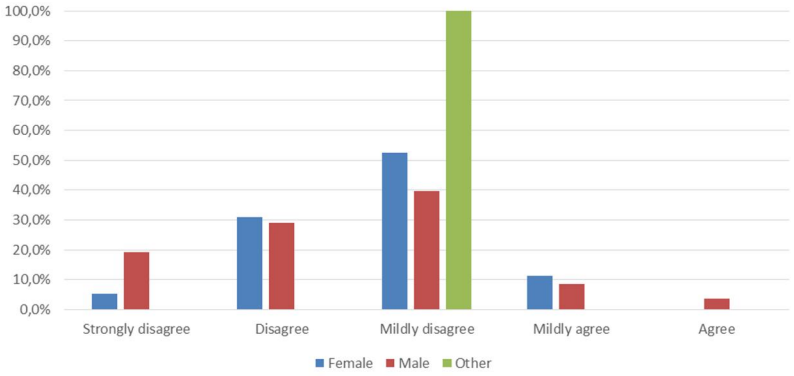

Figure 9. The risks of forest-based bioeconomy are greater than its benefits * Gender. Pearson Chi-Square: 0.018. 7 cells (46.7%) have expected count less than 5. The minimum expected count is .04.

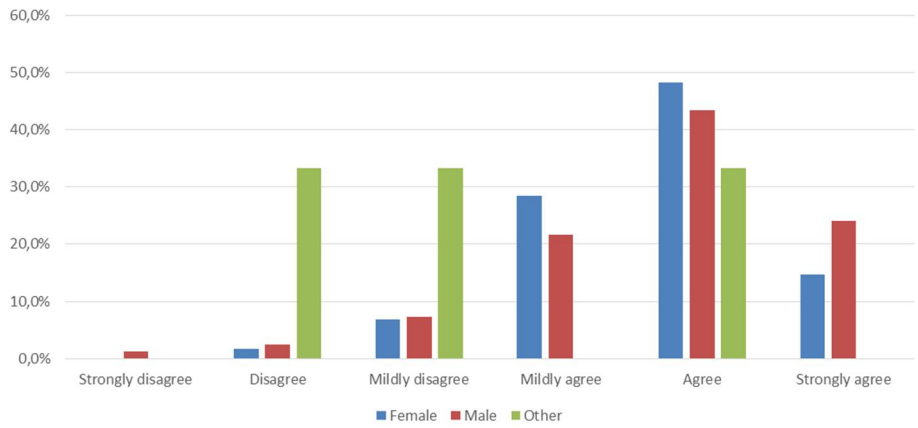

Figure 10. I trust information on forest-based bioeconomy from researchers and experts * Gender. Pearson Chi-Square: 0,022. 10 cells (55.6%) have expected count less than 5. The minimum expected count is .01.

5.1.2 Land/forest ownership

Land/forest ownership was a considerably more significant factor in the results than gender. Of the 34 variables, 10 (29%) differed by land/forest ownership status (p<0.05). In general, land/forest owners had more positive perceptions and expectations towards forest-based bioeconomy and perceived themselves to be more knowledgeable about the concept.

Forest/land owners tended to have more positive views about wooden buildings than the rest of the respondents. Additionally, all of the forest/land owners were familiar with WMC buildings. When studying the relation of forest/land ownership with the responses to the claims "Need more repairs and maintenance than steel or concrete buildings", "Need less insulation than steel or concrete buildings", and "Have a higher risk of fire than steel or concrete buildings", the results show statistical significance. 75% of forest owners agreed with the claim "Need less insulation than steel or concrete buildings", which would indicate that forest owners perceive wood to be an insulating material in itself. Those who were not forest/land owners perceived that WMC buildings need more maintenance and insulation than steel or concrete buildings. Concerning fire risk, non-forest/land owners believed WMC's to be more prone to fire than steel or concrete buildings. Most forest/land owners disagreed with WMC's contribution to global deforestation and biodiversity loss.

Forest/land owners perceived themselves to have a good knowledge of the meaning of forest-based bioeconomy (figure 11). Non-forest/land owners did not feel as acquainted with the term. Forest/land owners also showed slightly more agreement with claims "Forest-based bioeconomy decreases our dependency on oil and fossil fuels" (figure 12) and "Forest-based bioeconomy increases our economic self-sufficiency" (figure 13). Regarding agriculture-based bioeconomy (figure 14), forest/land owners disagreed with the claim that it is more important for society than forest-based bioeconomy.

Non-forest/land owners showed slightly more agreement with the claim "The risks of forest-based bioeconomy are greater than its benefits" (figure 15). From those who did not own forest/land, majority would trust information from environmental and civic organizations (figure 16). Forest/land owners answers were more evenly distributed to both sides of the range.

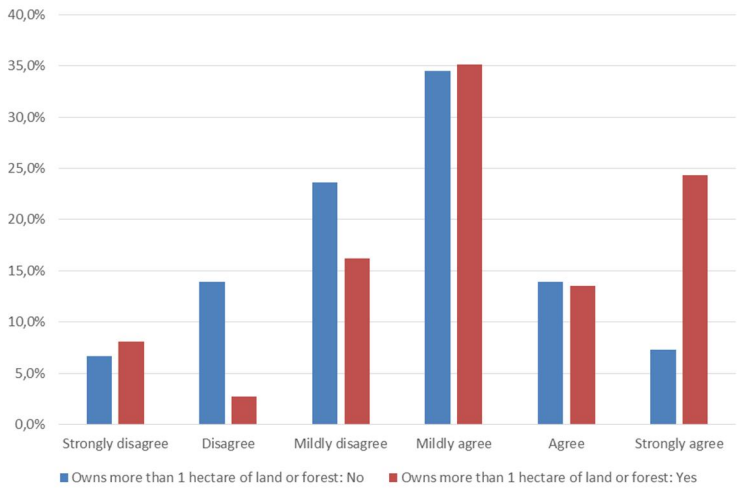

Figure 11. I know the meaning of forest-based bioeconomy * Land/forest ownership. Pearson Chi-Square: 0.028. 3 cells (25.0%) have expected count less than 5. The minimum expected count is 2.56.

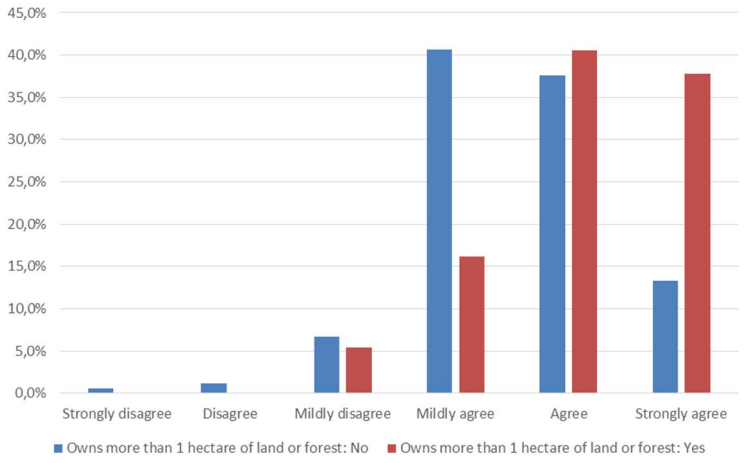

Figure 12. Forest-based bioeconomy decreases our dependency on oil and fossil fuels * Land/forest ownership. Pearson Chi-Square: 0.007. 5 cells (41.7%) have expected count less than 5. The minimum expected count is .18.

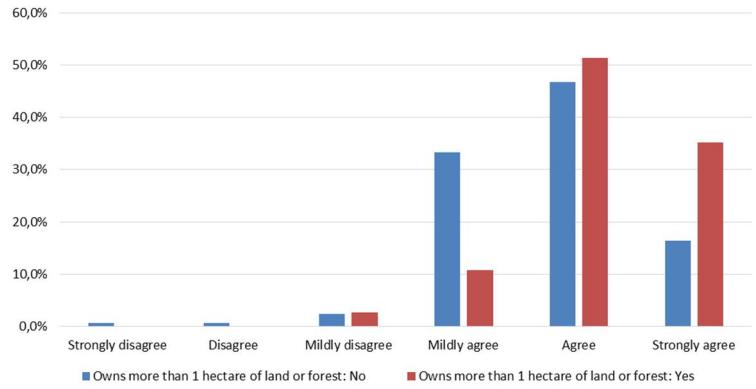

Figure 13. Forest-based bioeconomy increases our economic self-sufficiency * Land/forest ownership. Pearson Chi-Square: 0.047. 6 cells (50.0%) have expected count less than 5. The minimum expected count is .18.

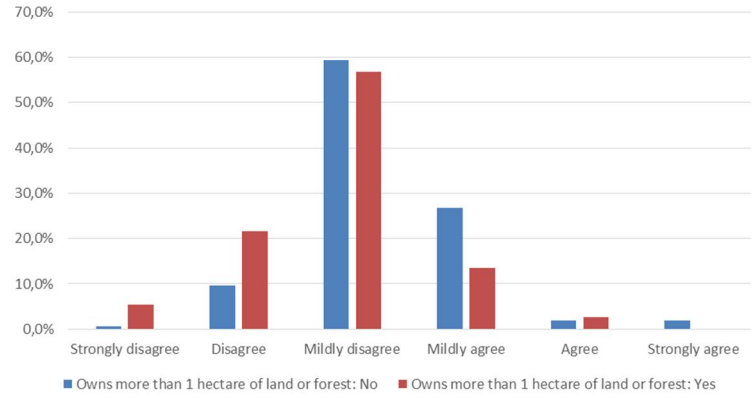

Figure 14. Agriculture-based bioeconomy is more important for society than forest-based bioeconomy * Land/forest ownership. Pearson Chi-Square: 0.046. 7 cells (58.3%) have expected count less than 5. The minimum expected count is .55.

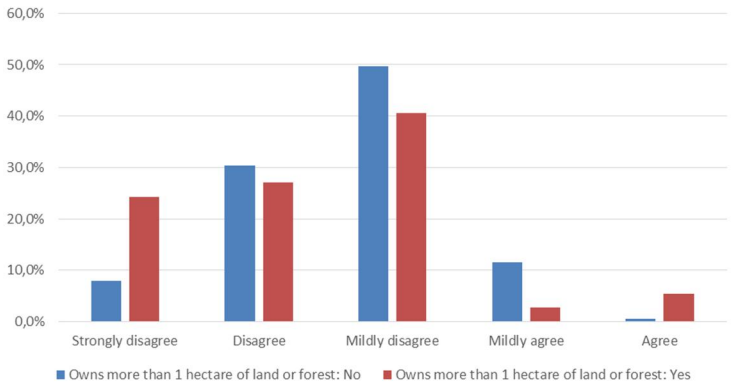

Figure 15. The risks of forest-based bioeconomy are greater than its benefits * Land/forest ownership. Pearson Chi-Square: 0.004. 4 cells (40.0%) have expected count less than 5. The minimum expected count is .55.

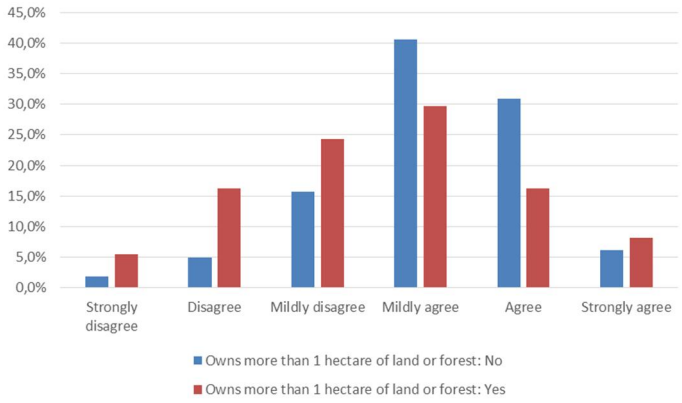

Figure 16. I trust information on forest-based bioeconomy from environmental and civic organizations * Land/forest ownership. Pearson Chi-Square: 0.036. 4 cells (33.3%) have expected count less than 5. The minimum expected count is .92.

Somewhat surprisingly, there was no statistical significance between the two groups in the claims “Land/forest owners need support to maintain and manage forests” and “Land/forest owners must be compensated monetarily for storing carbon in forests” (figures 17 & 18). The results indicate that, also from non-forest owners, there is strong support for both supporting forest owners in maintaining their forests and for monetary compensations paid to forest owners for storing carbon in their forests.

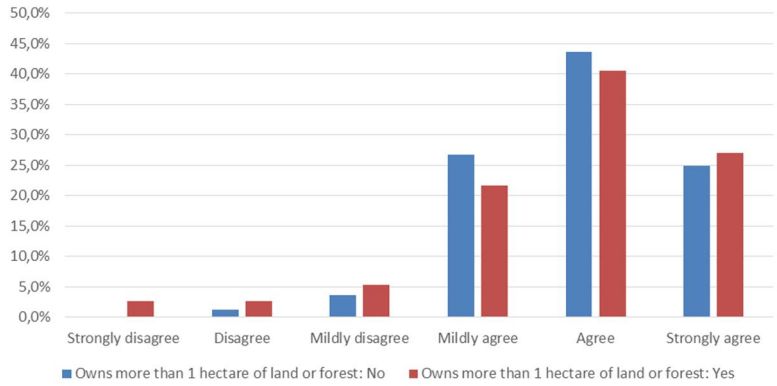

Figure 17. Land/forest owners need support to maintain and manage forests * Land/forest ownership. Pearson Chi-Square: 0.350. 5 cells (41.7%) have expected count less than 5. The minimum expected count is .18.

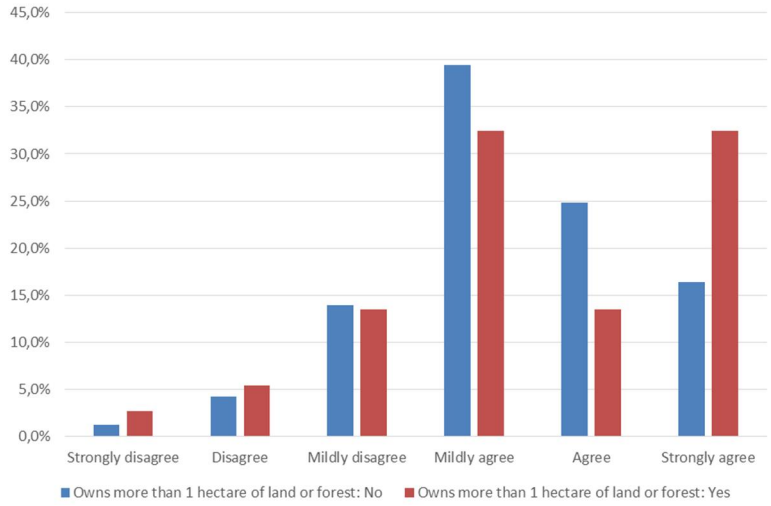

Figure 18. Land/forest owners must be compensated monetarily for storing carbon in forests * Land/forest ownership. Pearson Chi-Square: 0.246. 3 cells (25.0%) have expected count less than 5. The minimum expected count is .55.

Although the correlation between forest/land ownership and the claim "Forest-based bioeconomy generates new jobs and well-being in rural areas" did not prove to be statistically significant, it is noteworthy that all forest/land owners agreed with the claim. This would suggest that especially forest/land owners believe forest-based bioeconomy promotes rural areas in both economic and social terms.

5.2 Exploratory factor analysis

Exploratory factor analysis (Maximum likelihood estimation with Varimax-rotation) was conducted in order to find the in-depth relationships and constructs within the data. In the exploratory factor analysis, variables and data from the third section of the

survey (items 17-34), which dealt with perceptions regarding forest-based bioeconomy, were used.

The following describes the phases done to prepare the data for the analysis. Firstly, outliers were removed from the data. This removed 16 observations, which left 186 for the analysis. Variables that had almost the communality near unity were deleted from the analysis. Additionally, variables that did not load on any factor were deleted (cut-off point 0.3). This left a total of 14 variables into the analysis, and these loaded on four factors. Number of factors was interpreted based on Eigenvalues and the theoretical framework. The four factors explain 38% of the total variance existing. This is satisfactory considering the exploratory nature of the study. A four factor solution is also in line with the theoretical worldviews framework provided earlier. Based on the factor analysis, factor scores (using the regression method) were calculated for each participant.

According to the general guidelines of exploratory factor analysis, the Kaiser-Meyer-Olkin measure (KMO) and Bartlett's tests were done in SPSS (table 7). Both proved that the sample was suitable. The KMO measure was 0.663 and Bartlett's test of sphericity (p <0.000), while the minimum value for KMO is 0.6 (Metsämuuronen, 2011, p. 657). The relatively low Cronbach's Alpha values measuring the factor's reliability in factors 2, 3 and 4 can be explained by the low number of variables included in the factor. Tables 8 and 9 illustrate the final factor analysis solution and the included variables with the related theoretical IWF aspects and naming of factors.

Table 7. KMO and Bartlett's Test of Sphericity.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.663
Bartlett's Test of Sphericity	Approx. Chi-Square	457.179
	df	91
	Sig.	0.000

Table 8. Exploratory factor analysis (Maximum likelihood estimation with Varimax rotation, n=186) of urban citizens' perceptions on forest-based bioeconomy based on the Integrative Worldview Framework.

	Factor				
	1	2	3	4	IWF Aspect
Forest-based bioeconomy increases our economic self-sufficiency	0.811				Axiology
Forest-based bioeconomy decreases our dependency on oil and fossil fuels	0.655				Axiology
Forest-based bioeconomy generates new jobs and well-being in rural areas	0.611				Axiology
The risks of forest-based bioeconomy must be understood before we fully embark on it		0.594			Societal vision
All different views must be seriously considered when forest-based bioeconomy develops		0.529			Societal vision
The balance of nature is very delicate and easily upset		0.492		-0.374	Anthropology
Use of fossil fuels and non-renewable materials must be reduced as soon as possible		0.441			Societal vision
Despite our special abilities, humans are still subject to laws of nature		0.427			Anthropology
The risks of forest-based bioeconomy are greater than its benefits			0.972		Societal vision
Agriculture-based bioeconomy is more important for society than forest-based bioeconomy			0.371		Societal vision
Forest-based bioeconomy mainly benefits large companies and their shareholders			0.352		Axiology
Humans have the right to modify the natural environment to suit their needs				0.612	Anthropology
Environmental regulation limits overall economic development and growth				0.417	Societal vision
Humans will be able to solve environmental problems when technology develops				0.404	Anthropology
Cronbach's α	0.758	0.479	0.546	0.437	

Table 9. Naming and IWF relation of detected factors.

	Factor name	IWF aspects	IWF worldview
Factor 1	**Utilitarian**	Axiology	Modern
Factor 2	**Biocentric**	Societal vision, Anthropology	Postmodern
Factor 3	**Anti-bioeconomy**	Societal vision, Axiology	Traditional
Factor 4	**Anthropocentric**	Anthropology, Societal vision	Mixed (traditional/modern)

Claims about the trust in different actors (32, 33, and 34) had to be left out from the factor analysis, as they did not load on the above solution. Also the claim about domestic products (21) had to be left out. Reasons for these might be some underlying, undetected outliers in responses, or the question design. For example, it might be hard for respondents to identify the difference between researchers and government officials in the current bioeconomy discussions.

As expected, the variables did not fall straight into the four aspects provided in the Integrative Worldview Framework. The relation of detected factor analysis results and the IWF are theoretical and suggestive. The first factor loads on variables based on axiology that express a positive attitude and believe in the future chances of forest-based bioeconomy. The highest loading is on variable 18 "Forest-based bioeconomy increases our economic self-sufficiency." Also variables that express the decrease for oil and fossil fuels and an increase in jobs and well-being in the countryside were included in this factor. This factor represents a positive belief in the possibilities that forest-based bioeconomy offers and has an economical point of view. None of the sustainability-related issues loaded on this factor. This factor is thereby named "Utilitarian."

The second factor represents a risk cautious and environment-centric vision on forest-based bioeconomy. It loaded on several variables, such as "The risks of forest-based bioeconomy must be understood before we fully embark on it" and "All different views must be seriously considered when forest-based bioeconomy develops." This factor emphasizes an environmentally aware vision towards the bioeconomy and is named "Biocentric."

Factor three loads highly on claim "The risks of forest-based bioeconomy are greater than its benefits" and emphasizes a skeptical view towards bioeconomy. Additionally claims "Agriculture-based bioeconomy is more important for society than forest-based bioeconomy" and "Forest-based bioeconomy mainly benefits large companies and their shareholders" loaded on this factor, although on a low level. The factor is named "Anti-bioeconomy" based on its skeptical vision.

The fourth factor represents a human-centric view on environment utilization. It loaded on variables about economic utilization of nature and belief in technological progress. It differs from factor 3 in that factor 4 bases more on anthropological views, whereas factor 3 bases on societal vision. The fourth factor has a negative factor loading on claim "The balance of nature is very delicate and easily upset", which means that those who tended to score high on the other variables of factor 4 scored low, as in disagreed with, this variable. Thus, in this factor nature is not considered to be fragile in terms of balance. The fourth factor is named "Anthropocentric" due to its human-centric vision of the bioeconomy.

6 Discussion

Public acceptance is a key driver for the success of the forest-based bioeconomy. Understanding the perceptions and acceptance of citizens and consumers is essential for the future competitiveness and market diffusion of forest-based products. This study gives insights into the perceptions and worldviews of Finnish urban citizens regarding a forest-based bioeconomy. Since no previous study has been made, the results give an important and interesting view into the current bioeconomy discussion from a public level. Additionally, it provides basis for future research on the societal perceptions regarding forest-based bioeconomy. Urban citizens as consumers are at the core of bioeconomy since they have a great effect on how sustainable solutions become part of everyday consumption, especially as urbanization is increasing in Finland and elsewhere in the world.

In general, the results were encouraging: the perceptions were positive and knowledge of the topic was considered relatively high. Thus it can be claimed that Finnish urban citizens' perceptions and perceived knowledge are generally on a high level, supporting the results of previous studies (Kniivilä et al., 2017). Forests, forestry, carbon sinks and bioeconomy have recently been highly visible in the Finnish media and public discussion, a fact which may have had an effect on the results. In earlier, qualitative studies in Europe (see e.g. Sijtsema et al. 2016) consumers have identified as being unfamiliar with bio-based concepts and products, but it should be noted that bioeconomy does not necessarily have such a high political and public interest in other European countries. Moreover, the sample group of this study was comparably young. It is possible that this has biased the results to a more positive direction. Previously Finnish university students have been identified as having more positive views on the corporate social responsibility and the future of forest industries than their foreign counterparts (Pätäri et al., 2017).

Perceptions of WMC buildings were mainly positive. They were seen as faster and cheaper to build, healthier to live in, less harmful for the climate and generating more

income and well-being when compared to traditional steel or concrete buildings. Additionally, a surprisingly high amount of respondents claimed to be familiar with WMC buildings. WMC's are concrete, physical objects and thus might be easier for people to understand than more abstract things, such as the concept of bioeconomy. The majority of respondents identified fire risk to be higher in WMC's, which confirms earlier studies (see e.g. Ranacher et al. 2018; Larasatie et al. 2018). Lack of knowledge is one of the main challenges and barriers for the transition towards a sustainable bioeconomy. Information and education regarding bioeconomy products and their sustainability aspects are still needed among the public. For example, 44% of respondents believed that WMC buildings contribute to global deforestation and biodiversity loss. This implies that still more information about Finnish sustainable forest management practices, the technical properties and sustainability aspects of engineered wood products and WMC buildings is needed, and it also poses a challenge for the forest and construction industries. On the other hand, previous research has shown that those who are familiar with WMC buildings are less negative and more positive in their perceptions towards them, which should work as an encouragement for the construction industry (Larasatie et al., 2018). Nevertheless, the results can be seen as promising for the wood-construction industry. Sustainability is one of the megatrends impacting consumers' housing choices (Toppinen et al., 2018) and the forest-based industry transformation (Pätäri et al., 2016), and it can be expected that the importance of sustainability will only increase in the future.

In Ranacher et al. (2017) forests were detected to be an important contributor to ecosystem services. Based on these results, also Finnish urban citizens consider forests to be important actors in regards to carbon stocks and emission mitigation. Forest management was seen both as a threat and a possibility: 92% of respondents agreed that managed forests have great potential in reducing carbon emission, whilst 64% agreed that forest management might threaten the carbon stocks in forests. This implies that forest management practices are viewed critically; not all forests management is considered to be progressive in regards to carbon sequestration and storage. Somewhat surprisingly, support for maintaining forests and monetary compensations of storing carbon in forests for land/forest owners received strong support. This would indicate that alternative forest management practices, such as conservation strategies, are seen

as preferable by the urban citizens. These have lately been discussed in e.g. the climate and forest political themes of the Finnish parliamentary elections (Kjellber, 2019).

Economic aspects of bioeconomy were seen mostly as positive by the respondents. All three claims "Forest-based bioeconomy decreases our dependency on oil and fossil fuels", "Forest-based bioeconomy increases our economic self-sufficiency" and "Forest-based bioeconomy generates new jobs and well-being in rural areas" had high agreement from the respondents, which can be considered encouraging. Although forest-based bioeconomy generally is connected to forest industry companies and the like, respondents did not believe that mainly large companies and their shareholders would benefit from it. It can be that the relatively high number of forest/land owner respondents within the sample and in Finland altogether affects these results. Domesticity of forest-based products seems to be an important aspect. In this study, nearly 70% of respondents agreed with the claim "Forest-based bioeconomy products should be of domestic origin to be more sustainable." Domesticity of raw materials has likewise been highlighted in studies elsewhere, for example in Austria (Ranacher et al., 2018). However, in order for the forest-based bioeconomy to gain true legitimacy, social and ecological aspects of sustainability should be equally highlighted in the discussions. Further, the overall current consumption patterns should be questioned. As the world's population is increasing and most of the people will live in cities (United Nations, 2018), it is probable that not only consuming sustainably but also consuming less is needed (Hausknost et al., 2017).

A critical issue that arouse in the results is the citizens' perceived trust towards government officials. From the three information actor groups, government officials were trusted the least (see table 6). Similar results were found in Canada's British Columbia, where forest industry representatives and governmental and provincial actors received the most distrust whilst scientist were most trusted (Peterson St-Laurent et al., 2018). Trust in different actors was connected to also the level of support for forest management practices (Peterson St-Laurent et al., 2018). As Asveld et al. (2015) point out, bioeconomy is a complex phenomenon which makes it more important to common

people to be able to trust the information from other stakeholders. It can be that differentiation between government officials, and researchers and experts is difficult for citizens, when considering the distinctions of e.g. governmental research institutes, ministries and universities. High trust in researchers and experts indicates that the public is more inclined to depend on their views considering climate change issues, forestry and bioeconomy. Additionally, public's separation from nature is a challenge for the bioeconomy transition (Asveld et al. 2015). In an increasingly urbanizing world the connection to nature needs to be considered thoroughly e.g. in educational decisions.

As was seen in the results, forest/land owners are more knowledgeable about the properties of wood and have more positive perceptions towards bioeconomy compared to others. Therefore they would be important allies for bioeconomy stakeholders in market diffusion. Furthermore, forest owners are the main source of industrial roundwood in Finland (Hänninen et al., 2011) and sell their timber to companies who utilize the fibers, which also should make them benefit economically from the forest-based bioeconomy transition (Jonsson, 2011). Sijtsema et al. (2016) argue, that the personal benefits gained from different biobased products and concepts affect the perceptions associated with them, which supports the idea that forest owners should have a more positive attitude towards biobased products as they also get more benefits from them. In previous studies, younger, educated and environmentally aware people have been identified as an important target for increasing bioeconomy-related discussions and end-product demand (Høibø et al., 2015; Stern, Ploll, et al., 2018). In Austria (Stern, Ploll, et al., 2018), farmers were detected to have more critical perceptions of bioeconomy. However, the occupation of respondents was not asked in this survey and thus it cannot be said how that would affect the results of this study.

The use of Integrative Worldview Framework as a theoretical background proposed a more robust frame and a novel approach for the study. Previously, the postmodern and integrative worldview holders were found to have more concern over climate change and be more willing to make and support changes (De Witt et al., 2016). Postmodern worldview was evident in the Biocentric factor that emphasized nature as a whole and had careful approach to bioeconomy. Thus, it would be important to contact this citizen

group to better understand their visions. The Utilitarian group profiled in modern worldview and showed strong support for the emerging bioeconomy practices. Three of the IWF's four hypothesized worldviews were recognizable in the results. This suggests that the IWF is a useful tool for understanding the different perceptions and acceptance, and can further be applied in citizen and consumer-level studies. The detected worldview factors point to the direction that urban citizens' perceptions and worldviews are based on several different aspects consisting of e.g. values, knowledge, perceptions and conceptions and cannot be explained simply. Although the perceptions towards forest-based bioeconomy were in general positive, the concept still lacks consistency both in research and in public due to a vast range of different stakeholders. This was detected in the factor analysis where the factors did not form clearly and several iterations were needed to find a satisfactory stable solution. Additionally, the integrative worldview was not detected in the analysis as was expected and suggests that this worldview is still more speculative in terms of bioeconomy. Risk perception and the willingness to act pro-environmentally has been confirmed to correlate in previous studies (Peterson St-Laurent et al., 2018), and the Biocentric worldview factor gives this further support.

Two research questions were identified in the beginning of this thesis. Based on the framework, and results of the collected survey data and quantitative analysis, the following answers are proposed:

1. **What are the worldviews through which urban citizens understand the forest-based bioeconomy?**

Based on the factor analysis, the worldviews form a four-dimensional construct. The Finnish urban citizen worldviews consist of:

1) Utilitarian, which gives a high emphasis on the possibilities of forest-based bioeconomy and its overall economic effects;
2) Biocentric, which emphasizes understanding of related risks, social aspects and nature's fragility;
3) Anti-bioeconomy, which questions the risk-benefit ratio of forest-based bioeconomy; and

4) Anthropocentric, which concentrates on man's right to use and exploit nature. Additionally, nature is not considered as something of delicacy and being easily upsetting.

2. How do these worldviews affect the urban citizens' perceptions of the forest-based bioeconomy?

The detected worldview-factors base on different perceptions regarding e.g. economy, risk, nature and law and regulation. Traditional worldview, such as Anti-bioeconomy in this study, typically has a principled critical perception towards innovative solutions whereas the modern worldview holders, such as Utilitarian, tend to have a more practical view which is dependent on e.g. circumstances and benefits. Anthropocentric view, which could not with ease be pointed to only one worldview category, has attributes of the modern worldview in the belief in technology in helping to solve environmental challenges.

As expected, the worldviews provided by the IWF are not straight-forward in relation to the results. Only factor 1 "Utilitarian" can with relative ease be claimed to present a modern worldview due to its vision of a progressive bioeconomy by the instrumentalization of nature (De Witt et al., 2017). Factor 2 "Biocentric" bases on two aspects and is detected to represent the postmodern worldview; it takes into account the critical views of utilizing environment for economic purposes whilst valuing nature as itself. Risks are not seen straightforwardly as a negative issue, rather than emphasizing the need to fully understand and recognize the risks. Additionally, humankind was seen as a part of nature and not as its controller. Factor 3 "Anti-bioeconomy" is seen as traditional worldview based on the reluctance towards new innovations and a negative view on the large companies and their stakeholders; the traditional worldview emphasizes the importance of community and family whilst valuing traditional solutions in environmental problems (De Witt et al., 2017). Factor 4 "Anthropocentric" is harder to describe by the worldview framework; there is contents of both the traditional, as in seeing humankind as a controller of nature, and modern worldviews, as per the vision of the advantages of technological progress. Although the trust in different actors variables were not included in the factorial analysis, previously it has been showed that modern worldview holders trust more NGOs while traditional worldview holders are not sure who trust in the first place (De Witt et al., 2017). The fourth worldview of the

IWF theory, integrative worldview, was not detected in the factors as was previously expected.

Also other visions than the ones provided by IWF worldviews can be detected in the results. For example, three ideal type visions (Bugge et al., 2016) – bio-technology, bio-resource and bio-ecology visions – are present in the four-dimensional worldview solution. Additionally, the technology and industry driven vison and regional environmentalism vision (Stern, Ploll, et al., 2018) can be seen in the results. The data collection survey was based on combining earlier research articles to match the theoretical framework (Dunlap et al., 2000; De Witt et al., 2017; Larasatie et al., 2018; Peterson St-Laurent et al., 2018). It thus contributed to developing a more robust, profound survey form that can also be used as a basis for future research.

6.1 Limitations and future research

According to the results, Finnish urban citizens know and are familiar with WMC's, forest carbon storage and forest-based bioeconomy. Anyhow, it can be questioned whether using self-reported knowledge (as in claims "I am familiar with wooden multistory buildings", "I am familiar with how forests store carbon" and "I know the meaning of forest-based bioeconomy") give an overly positive image of the actual knowledge level of the participants. For example in Moser (2015) consumers overestimated their self-reported willingness-to-pay and behavior for sustainable products. Another way to have measured the participants' level of knowledge would have been by e.g. true/false quizzes. Additionally, as no definitions were given (about the meaning of WMC, forest carbon storage or bioeconomy), it should be noticed that each respondent might have a different definition of these items.

The results of this convenience sample study lack a wider generalizability as such and should be considered only as indicative. Further research is needed with a larger and wider sample to gain more reliable results. Also the quality of the data should be screened more, as in this study some respondents gave incorrect responses (answers missing from lines, two answers on one line, missing age etc.). The survey could be developed further by adding e.g. open-ended answers in which the respond defines the

terms by own wording. As pointed out by Ranacher et al. (2018), the perceptions of forest-based products can differ substantially between different groups, and thus the survey should be made with a wider sampling and with different target groups, such as in the countryside and other major cities in Finland, to see if and how the perceptions differ. Another point of question is who the participants were in general. It can be assumed that those who did answer were already more interested in the topic than those who did not, which consequently can affect the results. In addition, the sample had a high number of younger participants.

A similar survey but with the option "do not know/no opinion" would let us know what people are not familiar with, as from this study that really cannot be detected. The lack of these options was also criticized by many respondents. This could help us identify what aspects of bioeconomy should be informed and communicated more. In addition, a qualitative approach study would be interesting to get a more profound and detailed picture of the urban citizen perceptions. Interviews would give a more in-depth analysis of why Finnish urban citizens perceive and understand the forest based-bioeconomy as they do, and would contribute to a more detailed explanation to support the results of this thesis.

In some cases the wording of the claims caused questions. For example claim "Agriculture-based bioeconomy is more important for society than forest-based bioeconomy" was not well formulated, as some respondents said that it is equally important which also has a link to the lack of neutral/no opinion in the answer scale. In addition, sustainability in claim "Forest-based bioeconomy products should be of domestic origin to be more sustainable" was understood by some respondents to mean physical durability or longevity (*kestävyys* in Finnish), and not ecological sustainability. Thus, the wording should be screened precisely and considered if a consistent definition of key terms should be provided.

Although this thesis aimed to study the perceptions of urban citizens as consumers, it can be questioned whether forest-based bioeconomy products, at the moment, truly are consumer goods and if they are too distant and unfamiliar to the public. Most of forest

and wood based bioeconomy products are still on a development level and not strongly present in the consumer markets. It can be questioned, if for example apartments, as in WMC buildings, actually are consumer goods. Also other bioeconomy products such as new wooden textile fibers and bioplastics are still awaiting for the actual market diffusion (Hurmekoski et al., 2018). Although this study concentrated in studying citizens – as in urban people – it should be noted that only their perceptions and knowledge were researched, not their actual consumption behaviors and another study would be needed to shed light on the actual consumption of biobased products. Additionally, the survey should be conducted in other areas in Finland (other cities and countryside) to get a wider knowledge and a multiregional understanding of the perceptions of Finnish citizens.

Methodologically, descriptive statistics provided an overview to the data while factor analysis provided an exploratory approach to the data. The found four dimensions can be considered for screening in future studies. In order to get a deeper and more profound understanding, also other statistical methods such as clustering, regression analysis or confirmatory testing of the factor analysis model could be used. Regarding the theoretical framework applied, it would be interesting to see how large percentages of Finnish citizens divide between the different worldview factors. Additionally, adding divinity and spirituality-claims to the questionnaire might yield different results as per the given worldviews of the IWF. In this study these were excluded; Finland is a highly secular-rational nation (Inglehart, 2000) and thus these dimensions were not considered to be of high relevance regarding the aim of this study. However, adding these dimensions would be of importance when studying the more abstract and philosophical latent perceptions of the urban citizens.

7 Conclusions

Based on the results, it can be said that Finnish urban citizens have positive perceptions towards forest-based bioeconomy and its different aspects; this thesis covered WMC buildings, forest carbon sequestration and overall perception regarding forest-based bioeconomy. The main results of this study point to the direction that forest-based bioeconomy has gained acceptance by the Finnish urban citizens and is believed to provide positive societal outputs such as new jobs and wellbeing. This can be seen as a driver for the emerging bioeconomy clusters. Based on the Integrative Worldview Framework, four main worldviews regarding the bioeconomy perceptions – Utilitarian, Biocentric, Anti-bioeconomy and Anthropocentric – were detected. However, also skeptical views emerged in the analysis; additionally, sustainability was seen very differently in the emerged worldview constructs, where one was heavily pointed to sustainability issues. Further research is needed to understand the more in-depth correlations of different aspects.

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Appendixes

Appendix 1. Survey in English

Table A.1. Survey form in English.

UNDERSTANDING URBAN CITIZENS' PERCEPTIONS OF THE BIOECONOMY *This questionnaire is by a European-wide research network on Bioeconomy: PerForm – Perceiving the Forest-based Sector in the Bioeconomy (www.perform-bioeconomy.info). The project is funded by the European Forest Institute (www.efi.int) and facilitated through network member organisations in Austria/BOKU, Finland/Univ. Helsinki, France/IRSTEA, Germany/Univ. Freiburg, Italy/Univ. Padova, Russia/Univ. Saint Petersburg, Slovakia/Tech. Univ. Zvolen and Sweden/SLU.*		Strongly disagree	Disagree	Mildly disagree	Mildly agree	Agree	Strongly agree
My opinion of multi-storey building with a mostly wooden frame in [COUNTRY] [Choose what best corresponds your opinion]							
1	I am familiar with wooden multi-storey buildings	1	2	3	4	5	6
2	Are faster and cheaper to build than steel or concrete ones	1	2	3	4	5	6
3	Do not last as long as steel or concrete buildings	1	2	3	4	5	6
4	Need more repairs and maintenance than steel or concrete buildings	1	2	3	4	5	6
5	Need less insulation than steel or concrete buildings	1	2	3	4	5	6
6	Are healthier to live in than steel or concrete buildings	1	2	3	4	5	6
7	Have a higher risk of fire than steel or concrete buildings	1	2	3	4	5	6
8	Are less harmful to climate than steel or concrete buildings	1	2	3	4	5	6
9	Do contribute to global deforestation and biodiversity loss	1	2	3	4	5	6
10	Do generate income and well-being to more people than steel or concrete buildings	1	2	3	4	5	6
My opinion of storing carbon in forests in [COUNTRY]							
11	I am familiar with how forests store carbon	1	2	3	4	5	6
12	Managed forests have great potential to reduce carbon emissions	1	2	3	4	5	6
13	How forests are being managed can threaten carbon stocks in forests	1	2	3	4	5	6
14	Land/forest owners need support to maintain and manage forests	1	2	3	4	5	6
15	Land/forest owners must be compensated monetarily for storing carbon in forests	1	2	3	4	5	6
My opinion of forest-based bioeconomy in [COUNTRY]							
16	I know the meaning of forest-based bioeconomy	1	2	3	4	5	6
17	Forest-based bioeconomy decreases our dependency on oil and fossil fuels	1	2	3	4	5	6
18	Forest-based bioeconomy increases our economic self-sufficiency	1	2	3	4	5	6
19	Forest-based bioeconomy generates new jobs and well-being in rural areas	1	2	3	4	5	6
20	Forest-based bioeconomy mainly benefits large companies and their shareholders	1	2	3	4	5	6
21	Forest-based bioeconomy products should be of domestic origin to be more sustainable	1	2	3	4	5	6
22	Agriculture-based bioeconomy is more important for society than forest-based bioeconomy	1	2	3	4	5	6
23	The risks of forest-based bioeconomy are greater than its benefits	1	2	3	4	5	6
24	The risks of forest-based bioeconomy must be understood before we fully embark on it	1	2	3	4	5	6
25	All different views must be seriously considered when forest-based bioeconomy develops	1	2	3	4	5	6

26	Use of fossil fuels and non-renewable materials must be reduced as soon as possible	1	2	3	4	5	6
27	Environmental regulation limits overall economic development and growth	1	2	3	4	5	6
28	Humans will be able to solve environmental problems when technology develops	1	2	3	4	5	6
29	Despite our special abilities, humans are still subject to laws of nature	1	2	3	4	5	6
30	Humans have the right to modify the natural environment to suit their needs	1	2	3	4	5	6
31	The balance of nature is very delicate and easily upset	1	2	3	4	5	6
32	I trust information on forest-based bioeconomy from government officials	1	2	3	4	5	6
33	I trust information on forest-based bioeconomy from researchers and experts	1	2	3	4	5	6
34	I trust information on forest-based bioeconomy from environmental and civic organizations	1	2	3	4	5	6
Respondent background information							
35	Age						
36	Gender	Female		Male			Other
37	Do you own more than one hectare of land or forest?	No			Yes		
38	Which of the following best suits your current area of residence?	Urban		Suburb			Rural
Data collected through this survey will be treated confidentially and anonymously for the purposes of the PerForm project, in compliance with the General Data Protection Regulation (GDPR), Regulation (EU) 2016/679. By filling the questionnaire you give PerForm network staff the permission to process data you provide for the purposes of the PerForm project.							
To be completed by the surveyor							
Who collected:	*Where collected:*	*When collected:*					

Appendix 2. Survey in Finnish

Table A.2. Survey form in Finnish.

KAUPUNKILAISTEN KÄSITYKSET BIOTALOUDESTA *Tämä kysely on osa eurooppalaista biotaloustutkimushanketta PerForm – Perceiving the Forest-based Sector in the Bioeconomy (www.perform-bioeconomy.info). Tutkimuksen rahoittaa Euroopan Metsäinstituutti (www.efi.int) ja se toteutetaan hankkeen osanottajaorganisaatioissa Itävallassa/BOKU, Suomessa/Helsingin yliopisto, Ranskassa/IRSTEA, Saksassa/Freiburgin yliopisto, Italiassa/Padovan yliopisto, Venäjällä/Pietarin valtionyliopisto, Slovakiassa/Zvolenin teknillinen yliopisto ja Ruotsissa/SLU.*		Täysin eri mieltä	Eri mieltä	Hieman eri mieltä	Hieman samaa mieltä	Samaa mieltä	Täysin samaa mieltä
Mielipiteeni puurakenteisista kerrostaloista Suomessa [Vastaa mielipidettäsi parhaiten kuvaavalla vaihtoehdolla]							
1	Tiedän mikä puurakenteinen kerrostalo on	1	2	3	4	5	6
2	Ovat nopeampia ja edullisempia rakentaa kuin teräksiset tai betoniset kerrostalot	1	2	3	4	5	6
3	Eivät kestä yhtä pitkään kuin teräksiset tai betoniset kerrostalot	1	2	3	4	5	6
4	Tarvitsevat enemmän korjausta ja ylläpitoa kuin teräksiset tai betoniset kerrostalot	1	2	3	4	5	6
5	Tarvitsevat vähemmän eristystä kuin teräksiset tai betoniset kerrostalot	1	2	3	4	5	6
6	Ovat terveellisempiä asua kuin teräksiset tai betoniset kerrostalot	1	2	3	4	5	6
7	Ovat alttiimpia tulipaloille kuin teräksiset tai betoniset kerrostalot	1	2	3	4	5	6
8	Ovat vähemmän haitallisia ilmastolle kuin teräksiset tai betoniset kerrostalot	1	2	3	4	5	6

9	Edistävät globaalia metsä- ja biodiversiteettikatoa	1	2	3	4	5	6
10	Luovat enemmän tuloja ja hyvinvointia ihmisille kuin teräksiset tai betoniset kerrostalot	1	2	3	4	5	6
Mielipiteeni metsien hiilensidonnasta Suomessa							
11	Tiedän miten metsät sitovat hiiltä	1	2	3	4	5	6
12	Hoidetuilla metsillä on iso potentiaali hiilidioksidipäästöjen vähentämisessä	1	2	3	4	5	6
13	Metsien hyödyntäminen nykyisellään voi uhata metsien hiilivarastoja	1	2	3	4	5	6
14	Maan- ja metsänomistajat tarvitsevat tukea metsien säilyttämisessä ja hoidossa	1	2	3	4	5	6
15	Maan- ja metsänomistajien tulee saada korvauksia hiilensidonnasta metsissään	1	2	3	4	5	6
Mielipiteeni metsäbiotaloudesta Suomessa							
16	Tiedän mitä metsäbiotalous tarkoittaa	1	2	3	4	5	6
17	Metsäbiotalous vähentää riippuvuuttamme öljystä ja fossiilisista polttoaineista	1	2	3	4	5	6
18	Metsäbiotalous lisää taloudellista omavaraisuuttamme	1	2	3	4	5	6
19	Metsäbiotalous luo uusia työpaikkoja ja hyvinvointia maaseudulle	1	2	3	4	5	6
20	Metsäbiotalous hyödyttää lähinnä suuria yrityksiä ja näiden osakkeenomistajia	1	2	3	4	5	6
21	Metsäbiotalouden tuotteiden tulisi olla kotimaisia ollakseen kestävämpiä	1	2	3	4	5	6
22	Maatalouspohjainen biotalous on yhteiskunnallisesti tärkeämpää kuin metsäbiotalous	1	2	3	4	5	6
23	Metsäbiotalouden riskit ovat suurempia kuin sen hyödyt	1	2	3	4	5	6
24	Metsäbiotalouden riskit tulee tiedostaa ennen kuin investoimme siihen	1	2	3	4	5	6
25	Kaikki eriävät näkökulmat tulee ottaa hyvin huomioon metsäbiotalouden kehittyessä	1	2	3	4	5	6
26	Fossiilisten polttoaineiden ja uusiutumattomien materiaalien käyttöä tulee vähentää mahdollisimman nopeasti	1	2	3	4	5	6
27	Ympäristösääntely rajoittaa kokonaisvaltaista taloudellista kehitystä ja kasvua	1	2	3	4	5	6
28	Ihmiset pystyvät selvittämään ympäristöongelmia teknologian kehittyessä	1	2	3	4	5	6
29	Ihmiset ovat luonnonlakien alaisia kyvyistämme huolimatta	1	2	3	4	5	6
30	Ihmisillä on oikeus muokata luontoa tarpeidensa mukaisesti	1	2	3	4	5	6
31	Luonnon tasapaino on hyvin herkkä ja helposti järkkyvä	1	2	3	4	5	6
32	Luotan valtion viranomaisten antamaan tietoon metsäbiotaloudesta	1	2	3	4	5	6
33	Luotan tutkijoiden ja asiantuntijoiden antamaan tietoon metsäbiotaloudesta	1	2	3	4	5	6
34	Luotan ympäristö- ja kansalaisjärjestöjen antamaan tietoon metsäbiotaloudesta	1	2	3	4	5	6

Vastaajan taustatiedot

35	Ikä			
36	Sukupuoli	Nainen	Mies	Muu
37	Omistatko yli hehtaarin maata tai metsää?	Ei		Kyllä
38	Mikä seuraavista kuvastaa parhaiten nykyistä asuinpaikkaasi?	Kaupunki	Taajama	Maaseutu

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Kerääjä täyttää

Kuka keräsi:	*Missä:*	*Milloin:*