Applied Studies in Agribusiness and Commerce – APSTRACT
University of Debrecen, Faculty of Economics and Business, Debrecen
DOI: 10.19041/APSTRACT/2021/1-2/10

SCIENTIFIC PAPER

AN AGRO-FOOD WASTE COMMERCIAL UTILISATION BEHAVIOUR LENS AMONG URBAN AGRO-PRODUCER HOUSEHOLDS IN A DEVELOPING ECONOMY

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Abstract: *Small-urban farm businesses utilise agro-food waste emanating from own production and other levels of food supply chain activities to supplement conventional inputs. Out of these, the food produce surplus from agro-producer households is offloaded to the urban market. As such, the aim of the study was to assess the determinants of agro-food waste commercial utilisation behaviour among urban agro-producer households. An electronically-designed research tool was administered to 456 agro-producer households to collect self-reported estimates of their agro-food waste utilisation behaviour. Results indicated higher budget share towards conventional inputs (0.73) compared to agro-food waste (0.27) but the observed suboptimal production intensification could be rectified with increased use of agro-food waste. Structural equation modelling results indicated that attitude, environmental awareness and concern, motivation and perceived moral obligation had positive significant influence on commercial utilisation intention. The adopted constructs for the model could explain 79.1% of the commercial utilisation behaviour variance. Furthermore, commercial utilisation intention, risk perceptions and perceived behavioural control had significant influence on the commercial utilisation behaviour. Findings are an indicator that agro-food waste commercial utilisation intentions among small-urban farm businesses would likely transition to commercial utilisation behaviour. Since behaviour can be learnt and developed, aspects that contribute to commercial utilisation intentions and behaviour would need to be stimulated. As a strategy of reducing the collectible waste, urban authorities may introduce tailor-made programs meant to stimulate commercial utilisation intention and behaviour in small-urban farm businesses. In valuation of agro-food waste, methodologies that could factor in utility would provide more precise insights in its commercial utilisation.*
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Keywords:*Agro-food waste, inputs, commercial utilisation, path, SEM, SmartPLS, Kenya*

INTRODUCTION

Whereas there is evidence that urbanization is vital in the developmental process in economies, it is further argued that urbanization is not only a result but also a cause of economic development. However, unstructured population migration to urban areas may result to underemployment and unemployment as such contributing to non-optimal development. Unstructured migration may impact on the living standards of the populace and the sustainability of the existing systems. Furthermore, even if economic growth may have a positive relationship with urbanization, the association is non-linear (Turok & Mcgranahan, 2013; Nagashima, 2018; Nguyen & Nguyen, 2018). Economic growth is majorly realized through increased consumption and production. Increasing population in urban areas may be a growth indicator but also translates into more mouths to feed and generation of waste which necessitates food production and waste management. Moreover, in urban areas, opportunities such as open unused land spaces, demand for agricultural produce, the availability of waste and (absence of) supportive policy may exist. Considering the growing population and low income, the urban populace may adopt urban agriculture as a livelihood support system (Hallett, Hoagland, & Toner, 2016; Opitz, Berges, Piorr, & Krikser, 2016; Owuor, Brown, Crush, Frayne, & Wagner, 2017; van Tuijl, Hospers, & van Denberg, 2018).

Compared to conventional rural farms, urban farms are characteristically small and are likely to be disadvantaged

in terms of their economies of scale. Due to competing needs of land in urban areas, urban farming may also face rivalry especially from real estate. Notwithstanding this, small urban agribusinesses have a better access to markets owing to shorter supply chains thus reducing transaction costs. As a result they may scoop higher returns per unit compared to rural farms. More often than not, urban farms value contribution to the overall economy particularly in developing countries is not precisely known. As such they mostly miss out on government support such as subsidies. Amidst this neglect, recent evidence shows that urban agriculture is critical in realization of United Nations Sustainable Development Goals 1, 2, 3, 8, 11, 12, 13 and 15 (Akinlade, Balogun, & Obisesan, 2016; Nicholls, Ely, Birkin, Basu, & Goulson, 2020).

The scarcity of land compels urban agro-producers to intensify production. The adoption of the intensification angle embraces commercialization whose aim is to maximize production, minimize costs so as to maximize benefits. Productivity wise, urban farms are equally productive as conventional rural farms and in many cases they may be more productive due to intensification behaviour (Nicholls *et al.*, 2020). This is particularly achieved through intercropping, continuous production (non-seasonal through irrigation), vertical (and or hanging) gardening and possibly optimal use of farm inputs. This necessitates utilisation of available inputs such as organic household waste as a supplement input. Household waste mostly of the agro-food type is often considered to have a lower cost compared to conventional inputs. As a result, there arises commercial utilisation behaviour of household waste among agro-producers (Vandermeulen, Verspecht, & Huylenbroeck, 2005; FAO, 2007).

Though utilisation behaviour is traditionally a behavioural neurology and neuropsychology field related to brain damage where the conduct of a patient is observed and analysed (Pandey & Sarma, 2015), it is applicable in other behavioural fields. As such waste utilisation behaviour ought to be an illustration of the manner (series of actions) in which households put to use or sometimes readiness to use waste which they generate or that which they may acquire from external sources (Zhang *et al.*, 2015)this study examines factors associated with waste separation behaviors by analyzing responses to questionnaires distributed in Guangzhou, China. Data drawn from 208 of 1000-field questionnaires were used to assess socio-demographic factors and the TPB constructs (i.e., attitudes, subjective norms, perceived behavioral control, intentions, and situational factors. Whereas other waste management practises such as burning, burying and dumping are critical in waste management (Adu-boahen *et al.*, 2014; Brown, 2015), perhaps utilisation is comparably more economically beneficial (Okonko *et al.*, 2009; Kassaye, 2018; Mu'azu *et al.*, 2018). Utilisation involves recovery, reuse and recycling of waste through consumption, composting, processing and energy generation. Menyuka *et al.* (2018) explored the role of urban agriculture in the management and commercial utilisation of organic waste in urban areas. The researchers identified animal feeding, soil fertilization and energy production as avenues in which organic waste could be managed. They argued that utilisation of organic waste could contribute to food security, human capital engagement and economic growth, health and sanitation. Furthermore, urban areas are characterized by large population that lives under or barely above the poverty line which makes commercialization of urban agriculture a critical shock absorber amidst household income fluctuations.

Waste utilisation has been argued to be partially determined by the farmer's degree of intensification and the competing needs of agricultural waste. Especially for smallholder farmers, it has been shown that there is competition between fuel and feed needs from crop residue mainly after harvest. Furthermore, the household and farm socioeconomic characteristics including production goals may influence agro-producers' behaviour (Nigussie, Kuyper, & De Neergaard, 2015). Depending on the type of crop being produced or livestock being reared then waste utilisation behaviour may be influenced. For instance, legumes may not require agro-food waste but cereal crops may, but again vegetable's high nitrogen requirement may need even higher organic waste. Moreover, livestock such as pigs may influence the behaviour of agro-food waste utilisation compared to other types of livestock enterprises such as poultry. According to Baudron *et al.* (2014) and Valbuena *et al.* (2014), in India, Bangladesh and Kenya over 80 per cent of crop residue are left on the farm after harvest, therefore, being integrated into soil during farm preparation or under conservation agriculture practises.

The existing public waste collection services only cover an estimated 50 percent of the households in Nairobi City, Kenya. In taking the advantage of the ineffective waste management and non-substantive feed policies, small-urban farm businesses tap into agro-food waste as a supplementary input. Upon production, they supply the surplus to the urban market. So, (a) what factors influence the agro-food waste commercial utilisation intention among small-urban farm businesses and (b) does commercial utilisation intention translate to commercial utilisation behaviour of agro-food waste?

METHODOLOGY

Study area

The Nairobi City County is the administrative capital of Kenya and has had the highest share of Gross Domestic Product (21.7 per cent) contribution to the overall economy between 2013-2017 compared to the other Kenya's 46 counties (KNBS, 2019). The study area is the most urbanized (99.8 per cent) County in Kenya whose assessment is an indicator that it was suited to offer an urban reflection. Evidently, it is among the very few Counties that have shown effort towards recognizing and streamlining urban agriculture (RoK, 2014). Whereas trade and industry are the major economic activities

in the City, agriculture is practised on road and railway reserves, public spaces, backyards, river banks, under power lines, wetlands (Kamau, 2013), balconies and other open spaces including on steep and non-constructible areas. Land under urban agriculture is estimated to be 13.9 per cent of the Nairobi City County surface area (RoK, 2018).

Approximately, 2400 tonnes of waste per day is generated in Nairobi City where 30-40 per cent of this is not collected. Only about 50 percent of urban population are served with waste collection services. Notably, an estimated 45 per cent of waste in Nairobi City is recovered (NEMA, 2015) but its destination of use is not documented. One of the beneficiaries of waste generated in the County is urban agriculture, which utilise organic waste mostly of agro-food type. Although this is indicative of the urban residents behaviour towards waste, urban agro-producers survey would provide a more precise picture since they have a greater potential in utilisation of waste compared to other waste supply chain actors. The common urban agriculture activities were projected to include vegetable and fruit, flowers and ornamental plants, cattle, goat, pig, poultry and rabbit rearing among others (Kamau, 2013; MERDA, 2015; RoK, 2018) which are meant for home use and or market (MERDA, 2015). The diverse agricultural practices among urban agro-producers may provide clues into the current commercial utilisation behaviour and how this could be enhanced to enable exploitation of agro-food waste resource.

Sampling

A total of 456 agro-producer households were sampled using a multistage sampling approach. The procedure involved clustering of the City's 85 electoral wards from which ten administrative wards were purposively selected based on their involvement in market-oriented urban agricultural activities. The study was conducted in Kahawa West, Mwiki, Ruai, Githurai, Njiru, Karura, Mugumo-ini, Karen, Uthiru/Ruthimitu and Waithaka wards. A mix of simple random sampling (in cases where there was a respondent list) and snowballing (where there was no respondent list) sampling methods were used to identify the respondents.

Research instrument and data

An electronically-structured questionnaire was designed on KoBoToolbox platform to capture self-reported commercial utilisation behaviour of agro-food waste among urban agro-producer households. The questionnaire was then administered by duly trained enumerators using KoBoCollect mobile application using smartphones. The choice of the questionnaire design was informed by the safety of data collected compared to print-out questionnaire (it was projected that there was higher sense of responsibility with own mobile gadget compared to a paper questionnaire). In addition, unlike the paper questionnaire output which involve manual keying-in of data, the electronic-design questionnaire data is automatically stored in a spreadsheet form once filled out. Questionnaires were sent to the KoBoToolbox server where they could be easily downloaded and exported to other file formats. The latter was also cost-friendly. However, the electronic-design questionnaire was longer (page wise) based on the disaggregated nature of research questions compared to the paper format which could have aggregated questions mainly using tables.

Prior to the survey, potential enumerators were invited to make applications through a network of professionals in agriculture to be enrolled for the survey. The basic application qualifications included possession of a smartphone (at least 25.4mm screen size) and power bank gadget. Additionally, the applicants were then screened for suitability based on their educational background (at least a Diploma) and experience in conducting similar surveys. The selected enumerators were involved in a two days training on the administration of the questionnaire and additional two days for pilot testing. The enumerators were then reassessed based on the training and pre-testing indicators where a team of six enumerators was selected. Whereas an electronic questionnaire was mainly used, the enumerators were trained on both paper and electronic formats. The paper questionnaire was to be used as an alternative in case of failure of the mobile gadgets. For the few instances paper questionnaire was used, the data was keyed-into the mobile application the same day by the concerned enumerators.

Introductory support to potential respondents was done by local administrators and agricultural extension officers which was aimed at improving the response rate. Once the survey was completed, the data were downloaded in a spreadsheet format and exported to Stata 15 for cleaning and pre-estimation test analysis. Analysis was carried out to obtain the research results which enabled discussion and drawing of implications of the study.

Theoretical framework and hypothesis development

In assessing behaviour, the Theory of Planned Behaviour (TPB) has been widely accepted as a basis for demonstrating the relationships that arise from behaviour constructs towards a behaviour under consideration (Ajzen, 1985, 1991). According to Ajzen (1991), intention towards performance of a behaviour can be projected using the individual attitude (AT) towards the behaviour, subjective norm (SN) and perceived behavioural control (PBC) contexts. Depending on the approval nature of an individual on their AT, SN and PBC, it is a pointer of strong intention to perform a given behaviour. As the TPB continue to be applied in different fields, new ideas for its predictive power improvement have been suggested. Being a non-static theory, additional variables to the TPB model have been successfully implemented in various studies (Taylor & Todd, 1995; Chu & Chiu, 2003; Nguyen *et al*., 2018; Loan, Takahashi, Nomura, & Yabe, 2019). Ajzen (1991) on his part felt that where warranted by significant contribution towards the behaviour, additional variables could be considered. This has made the theory more appealing to researchers thus becoming increasingly developed.

One of the major beneficiaries of TPB applications is waste generation and management (Tonglet, Phillips, & Read, 2004; Ioannou, Zampetakis, & Lasaridi, 2011; Caplescu, 2014; Russell, Young, Unsworth, & Robinson, 2017; Nguyen *et al.*, 2018). It is noteworthy that various analytical methodologies are often employed in combination with behavioural theories in explaining waste related behaviours. For instance, in empirical application of logit and ordered logit model to model home composting behaviour in Vietnam, Loan *et al.* (2019) findings indicated that motivational factors in terms of knowledge on composting, attitude and garden ownership were the basis for composting behaviour. Moreover, a general pro-environmental behaviour by a household was indicated to be a likely influence on composting. However, although training in composting was important in explaining participation decision, it did not determine the level of participation.

Unlike Loan *et al.* (2019), Philippsen (2015) employed an extended TPB and multiple regression to assess students' intention to recycle waste. Perceived moral obligation, past behaviour and inconvenience had a significant prediction of behaviour to recycle. Similarly, Nduneseokwu *et al.* (2017) and Nguyen *et al.*, (2018) used the TPB in the assessment of e-waste recycling intention in Nigeria and Vietnam respectively. However, the former study extended the analytical framework with infrastructure and economic incentives and used hierarchical regression for analysis. Infrastructure was a moderating variable for attitude and subjective norm which meant that establishment of appropriate infrastructure would result to weaker influence by attitude and subjective norm on intention to recycle. Conversely, Nguyen *et al.* (2018) applied Structural Equation Modelling (SEM). The findings indicated that environmental awareness, attitude, social-pressure, regulations and laws, recycling cost and inconvenience had significant prediction on e-waste recycling intention.

As a form of utilisation, recycling behaviour of waste is key in environmental quality. Using SEM, Jekria & Daud (2016) research findings on environmental concern and recycling behaviour in Malaysia showed that attitude on recycling was determined by environmental concern whereas attitude enhanced concern thereby resulting to improvement in the recycling behaviour. Earlier, Chu & Chiu (2003) extended and applied the TPB constructs in the assessment of household waste recycling behaviour. Beyond the usual AT, SN and PBC, they added perceived moral obligations (MO). The findings of the study indicated that the extended TPB constructs PBC, AT, SN and MO consecutively had significant influence on the recycling behaviour.

Similar to TPB, SEM has become widely accepted in assessment of human behaviour in waste related issues (Si *et al.*, 2019). Most often, SEM has been employed to assess and predict the structural relationships depicted by TPB thus making the two almost synonymous. Generally, SEM consists of two parts; the structural portion establishing the relationships between latent variables through simultaneous equations and the measurement part that shows associations between latent variables and observed variables (Bentler, 1980). According to Bentler (1980) and Kaplan (2001), the structural portion is basically written as;

$$\eta = B\eta + \Gamma\xi + \zeta \quad (1)$$

Where η is the vector of endogeneous latent variables (criterion), B is the matrix of coefficients of regressions of η variables on other η variables, Γ is the matrix that contains regression coefficients of η's on ξ's. In addition, ξ is the vector of exogenous latent variables (predictors), and ζ is the vector of residual terms (specification errors). Notably, the B matrix has zeros on the diagonal, an implication that a variable cannot cause itself, in this case η.

The measurement portion of SEM can be written as;

$$y = \Lambda\_y\, \eta + \varepsilon \quad (2)$$

$$x = \Lambda\_x\, \xi + \delta \quad (3)$$

Where y is explained variable, x are the explanatory variables, Λ_x and Λ_y are matrices for factor loadings, and ε and δ are vectors of uniqueness.

In this respect, variances and covariances for the variables, multipliers and disturbance terms are specified. Since SEM is meant to validate theories in regard to constructs, possibilities exist on absence of effect of constructs on others and certain variables failing to load on others. Therefore, through hypothesis formulation some elements that are used in SEM may be fixed to zero whereas the rest of the parameters are estimated. Also possibilities of discarding some indicators for inadequate validity and relevance exist. The covariance matrix of the fixed and non-fixed parameters portrays a specific structure defined as;

$$\Sigma = \Sigma(\Omega) \quad (4)$$

Where Σ is the population covariance matrix, and $\Sigma(\Omega)$ is Ω matrix valued function containing all the parameters of the SEM.

Considering that (a) waste is generally filthy and unpleasant if mismanaged, (b) public authorities are responsible for waste generated in urban areas, and (c) the respondent sample were farmers, additional constructs were incorporated into the TPB. Environmental awareness and concern, motivation, moral obligation and risk perceptions were hypothesised to have an additional stake in determining the commercial utilisation behaviour of agro-food waste beyond (Ajzen, 1985, 1991) constructs.

Attitude (AT): Refers to positive or negative evaluation about a behaviour which is formed through behavioural beliefs (Ajzen, 1985). Basically, individuals form behavioural attitudes based on what they know or something they have experienced before. Therefore, the judgement rendered on a behaviour is essentially based on older beliefs. In forming attitudes, individuals may amalgamate five to ten beliefs (Fishbein & Ajzen, 1975). This implies that a given attitude towards a behaviour is a summation of relevant behavioural beliefs. As a result, a positive or negative preference arises towards the behaviour (Ajzen, 1991). Of course, if the individual perceive the behaviour as disruptive, tiring, or does not fit to the established personal arena then they will

form a negative attitude and if otherwise positive. Biased and irrational attitudes cannot be ruled out (Ajzen, 2015) which implies objectivity may miss out in forming attitudes. An individual will most likely engage in a behaviour if his/her attitude towards it is positive whereas the opposite is true (Ajzen & Fishbein, 2005) people, institutions, or events are found to correlate well with behavioral patterns but not with specific behaviors; to predict specific actions requires a measure of attitude toward the behavior itself. The processes whereby general attitudes may influence performance of specific behaviors are currently the subject matter of one major line of theorizing and research best represented by Fazios (1990a. Considering commercial utilisation behaviour intention of agro-food waste, what is the likely attitude towards it? Therefore, it is hypothesised that;

H1a: AT has positive significant relationship with agro-food waste commercial utilisation intention (CUI).

H1b: AT has positive significant relationship with risk perception (RP)

Subjective Norms (SN): Refers to beliefs of an individual or household about whether people they look up to would approve or disapprove on their specific behaviour. It extends to performing behaviours that the people they hold in high regard or the society approves. The behavioural construct comes with social pressures in performing a behaviour (Zhang *et al.*, 2015this study examines factors associated with waste separation behaviors by analyzing responses to questionnaires distributed in Guangzhou, China. Data drawn from 208 of 1000-field questionnaires were used to assess socio-demographic factors and the TPB constructs (i.e., attitudes, subjective norms, perceived behavioral control, intentions, and situational factors; Aktas *et al.*, 2018)this study examines factors associated with waste separation behaviors by analyzing responses to questionnaires distributed in Guangzhou, China. Data drawn from 208 of 1000-field questionnaires were used to assess socio-demographic factors and the TPB constructs (i.e., attitudes, subjective norms, perceived behavioral control, intentions, and situational factors. Under the current study, it is a belief about other people's (other households, social groups and or community) standard behaviour in regard to commercial utilisation intention/behaviour of agro-food waste in urban agriculture. As such subjective norm is likely to influence household agro-food waste commercial utilisation intention positively. Then, it is hypothesized that;

H2: SN on agro-food waste has positive significant relationship with agro-food waste CUI.

Perceived Behavioural Control (PBC): Refers to perception of ease or difficulty of performing a behaviour. In instances where they feel certain (strong conviction), intention alone is projected to predict behaviour to be performed. Conversely, when there is uncertainty about the control ability towards the behaviour performance then PBC has a direct link with behaviour. Depending on the situation, individuals or households may feel adequately or inadequately equipped to perform a behaviour. Based on experience (past performance of the same or similar behaviour) or resources (monetary or knowledge) a household has, the scenario may affect (enables or hinders) their ability to perform an intended behaviour (Stancu, Haugaard, & Lähteenmäki, 2016; Werf, Seabrook, & Gilliland, 2019) such as commercial utilisation of agro-food waste. Therefore, it is hypothesised that;

H3a: PBC has positive significant relationship with CUI.

H3b: PBC has positive significant relationship with commercial utilisation behaviour (CUB).

Risk perceptions (RP): Refers to beliefs of a potential loss or harm which is subjective of an individual's evaluation of a situation or performing a behaviour. Whereas it may seem to be based on the level of ignorance, the degree of risk perception (RP) assigned to a behaviour may be entirely or partially influenced by an individual's reference. The level of risk of a behaviour is a representation of its probability and consequences of harm arising from the behaviour; perceived likelihood, sustainability and severity (Darker, 2013; Brown, 2014). Thus, it is hypothesised that;

H4a: RP have negative significant relationship with CUB

H4b: RP have negative significant relationship with CUI.

Environmental awareness and concern (EAC): Refers to knowledge, positivity and sensitivity towards ecological matters. The construct is an indicator of willingness to protect the environment. Intention of utilising agro-food waste commercially in urban areas may be indirectly taken to mean protective nature of a household towards effects of such waste on the environment. Environmental knowledge was positively associated with the intention to purchase energy efficient appliances (Li, Li, Jin, & Wang, 2019). Jekria & Daud (2016) and Nguyen *et al*. (2018) established a positive influence of environmental awareness towards intention to perform a behaviour. Therefore, it is hypothesised that;

H5a: EAC has positive significant relationship with AT

H5b: EAC has positive significant relationship with CUI

Motivation (MT): Refers to what causes individual households to conduct agro-food waste commercial utilisation. The reasons may emanate internally (environmental beliefs, guilt, intrinsic goals and attitudes) or externally (monetary benefits and social pressure related to laid down rules and laws)(Johansson, 2016; Nguyen & Watanabe, 2020)waste volumes are increasing rapidly and the World Bank estimates a 70% global increase in municipal solid waste up to 2025. Waste may have serious environmental consequences and there is a strong correlation between solid waste generation rates and greenhouse gas emissions. These two observations alone indicate that this development is not sustainable. Recycling is one of the most important actions currently available to reduce the environmental impact of waste. While, waste recycling in OECD countries is reported to be approximately 22% on average, many developing countries have recycling rates in the range of 1–3%. A key aspect in succeeding with any recycling effort is how authorities and other actors relate to

both informal and formal waste workers. This paper reports on the findings of a systematic literature study with the aim of exploring waste recycling behavior, with a special focus on motivational factors, both physical and psychological, behind recycling. Three levels of descending importance for recycling have been identified, where two are vital for success, and the third is desirable; 1. The motivators may affect intentions of an individual household (Johansson, 2016)waste volumes are increasing rapidly and the World Bank estimates a 70% global increase in municipal solid waste up to 2025. Waste may have serious environmental consequences and there is a strong correlation between solid waste generation rates and greenhouse gas emissions. These two observations alone indicate that this development is not sustainable. Recycling is one of the most important actions currently available to reduce the environmental impact of waste. While, waste recycling in OECD countries is reported to be approximately 22% on average, many developing countries have recycling rates in the range of 1–3%. A key aspect in succeeding with any recycling effort is how authorities and other actors relate to both informal and formal waste workers. This paper reports on the findings of a systematic literature study with the aim of exploring waste recycling behavior, with a special focus on motivational factors, both physical and psychological, behind recycling. Three levels of descending importance for recycling have been identified, where two are vital for success, and the third is desirable; 1. Cecere, Mancinelli, & Mazzanti (2014) indicated that waste prevention behaviour was dependent on intrinsic motivation. Nguyen & Watanabe (2020) was of the view that motivation could be initiated on an individual/household's confidence on the ability to perform a behaviour. Additionally, high PBC was associated with low motivation and vice versa. The argument was that those who exhibit high PBC are likely to be complacent. As a result they lack the motivation (low if any) to participate in effortful reasoning process towards the intention of performing a behaviour. Ajzen (2012) went further to indicate that intention is influenced by motivation. Therefore, it is hypothesised that;

H6a: MT has positive significant relationship with PBC

H6b: MT has positive significant relationship with CUI

Perceived moral obligations (MO): Refers to non-legally binding duty that a household may feel it owes and ought to perform which gives rise to moral responsibility. Therefore, the performance of a behaviour is gauged in terms of the perceived correctness or incorrectness (Ajzen, 1991). MO is generally based on self-expectation informed by personal values, which is internal unlike SN that arises from social (external) pressure. However, one's values or personal norms could be easily diffused to the society as such becoming part of subjective norms. Beck & Ajzen (1991) indicated a potentially significant association between MO and SN. Considering a household, its MO is its moral standing towards commercial utilisation intention. Chu & Chiu (2003) findings indicated that MO had positive influence on the intention to recycling waste in Taiwan households. In concurrence, MO was found to positively influence the intention to sort solid waste among the youth in China (Shen, Si, Yu, & Si, 2019). In predicting climate change mitigation behavioural intentions in Taiwan, Chen (2020) findings showed that MO had critical effect.

H7a: MO have positive significant relationship with SN

H7b: MO have positive significant relationship with CUI

Commercial utilisation intention (CUI): Refers to conscious plans that commercial utilisation will be undertaken in an urban agro-producer household. This may also be associated with the probability in performing CUB or the effort thereof (Fishbein & Ajzen, 1975; Ajzen, 1991). Unclear plans, low probability or low efforts would be expected to result to low CUB whereas the vice versa is true (Konerding, 1999). The link between CUI and CUB would be an indicator of transformation of intentions to behaviour. Thus, it is hypothesised that;

H8: CUI has positive significant relationship with CUB

Contextual factors (CF): Refers to factors that characterize the settings in which urban households operate in, other than the TPB constructs. In numerous TPB studies, contextual (background) characteristics are often not considered (Miao, 2015; Shen et al., 2019). They may include socio-economic and institutional factors, personality, intelligence, emotions, general attitudes, and life values among other factors. They are generally assumed to have a stake in developing intention (Ajzen, 1991; Ioannou et al., 2011; Ajzen, 2015). Although Ajzen (2015) was of the view that CF are only expected to indirectly influence behavioural intentions, this argument does not stand since Zhang (2014) established a direct association between CF and behavioural intentions to policy changes. Thus, it is hypothesised that;

H9: CF have positive significant relationship with CUI

The indicators that were used to build the study constructs are as presented on Table 1 and Appendices. However, the picked indicators are only a synthesised form of the original after undergoing a rigorous validity and reliability assessment; collinearity, composite reliability, average variances extracted, cross loadings and cross-validated redundancy tests were executed as shown in the results and discussion section. The indicators that did not meet the established criteria (0.70 indicator loading) were dropped as shown in Table 1 and Figure 1. In implementing the selection of indicators used, SmartPLS which is popularly known as PLS-SEM or PLS path (Ringle, Wende, & Becker, 2015) was employed. The software choice was based on its ability to estimate complex models without a pre-imposed distributional requirement. It is also appealing to due to its causal-predictive ability and user-friendliness. As such it enables relational estimation with much ease without advance technical knowledge compared to other SEM software such as CB-SEM (Hair, Risher, Sarstedt, & Ringle, 2019) and Stata-SEM. The CF construct included employment status of the woman of the household (employed=1; housewife=0) and urban agriculture knowledge (1=very low, 2=low, 3=moderate, 4=high, 5=very high).

Table 1: Indicators used to estimate the model constructs

Construct	Measurement item/indicator	Status
	I am interested in agricultural and food waste commercial utilisation	Dropped
	I think agricultural and food waste utilisation is cost friendly	Dropped
AT	Agro-food waste utilisation ought to be promoted	Picked
	Agro-food waste utilisation is an appropriate way to manage solid waste in urban areas	Picked
	When utilised properly agricultural and food waste is beneficial	Dropped
	Agricultural and food waste is unsafe for utilisation	Dropped
	The County government and landlords should be solely responsible for the management of agricultural and food waste	Dropped
SN	Most of the people I look to in terms of values utilise agro-food waste	Picked
	It is a common practise for people to utilise agro-food waste in urban agriculture	Picked
PBC	I have made it a routine to utilise agro-food waste upon generation	Picked
	It is quite effortless for me to utilise agro-food waste	Picked
	Inadequate knowledge makes agricultural and food waste utilisation very difficult for me	Dropped
EAC	Agro-food waste has economic value	Picked
	The little agricultural and food waste generated by every household if left unmanaged could potentially ruin the environmental quality	Dropped
	Failure to properly manage agricultural and food waste could contribute to negative health effects	Dropped
	I feel disgusted when I see or pass near agricultural and food waste that has been improperly disposed	Dropped
	I feel freshened and satisfied when my surroundings are clean	Picked
	I feel guilty if I dispose off the agricultural and food waste without utilising it	Dropped
PMO	I take it as my duty to utilise agro-food waste emanating from my household	Picked
	I feel if every household was to utilise its agricultural and food waste we would have a better environment	Dropped
	Everybody within a household has a role to play in managing agro-food waste especially through utilisation	Picked
	My religion encourages prudent utilisation of resources	Dropped
	I usually feel at peace when I utilise waste beneficially	Picked
MT	In my household, agro-food waste utilisation is a waste management strategy	Picked
	By utilising agricultural and food waste we set a good example to others	Dropped
	Having had faced food inadequacy in the past I ensure that whenever agricultural and food waste is generated I put it to good use	Dropped
	My household has some land space where we utilise agricultural and food waste	Dropped
	My household utilises agro-food waste as a cost-saving mechanism	Picked
RP	I would associate agro-food waste utilisation with pests and pathogen risk	Dropped
	I would associate agro-food waste utilisation with injurious elements risk	Picked
	I would associate agro-food waste utilisation with health and poisoning risk	Dropped
	I would associate agro-food waste utilisation with death and or investment loss risk	Dropped
	I would associate agro-food waste utilisation with pollution risk	Dropped
	I would associate agro-food waste utilisation with costly treatment of the affected risk	Picked
CUI	I plan to utilise agro-food waste on a regular basis in order to manage waste emanating from my household	Picked
	I plan to participate in waste management drives in my neighbourhood	Picked
	I plan to encourage others to utilise agro-food waste in order to improve waste management	Picked
	I intend to properly dispose off agricultural and food waste emanating from my household if am not able to use it	Dropped
	I always segregate agricultural and food waste before using it	Dropped
CUB	I regularly utilise agro-food waste from my household	Picked
	I regularly outsource agro-food waste for use in my household	Picked
	I always ensure I disinfect agricultural and food waste before utilising it	Dropped
	I sometimes sell agricultural and food waste to others who can use it	Dropped
	I sometimes give away agricultural and food waste to others who can use it	Dropped

Indicators scale: 1=strongly disagree (very low), 2= disagree (low), 3=moderately agree (moderate), 4=agree (high), 5=strongly agree (very high)

RESULTS AND DISCUSSION

Agro-food waste utilisation and produce sales

Kales enterprise was the most popular enterprise (86%) among urban agro-producer households for the three months period under consideration. Cereals as well as spinach indicated high production participation at 64% and 60% respectively. Notably, legumes, indigenous vegetables, poultry and banana enterprises had over 50% production participation rate. Value of agro-food waste used was highest in the vegetable group of enterprises followed by livestock, and tree and flower propagation. However, the highest mean produce sales were from the livestock enterprise followed by poultry, vegetables, and tree and flower propagation consecutively. The mean total value of waste utilised in urban agro-producer households was Kes9,724.15[1]. This implied that the budget share value of waste utilised was 27% in relation to conventional inputs (see the section that follows). This proportion presents a tangible contribution of agro-food waste in urban agriculture thus having a role in the urban food supply chain.

Average garden size used was 311m^2 although the range was 10m^2 (especially for roadside tree and flower propagators) to 6,000m^2. The agro-producers indicated that garden size under use fluctuated seasonally. Some agro-producers had up to 12,000m2 garden size during some production periods (especially during dry weather) to maximize on the value of produce during the time. However, Ogendi, Mukundi, & Orege (2019) findings had indicated that city producer had garden sizes of 0.5 to 1.0 acres; approximately 2,000-4,000m^2. The disparity could be explained by seasonal fluctuations but use of wetlands also increased farm sizes in urban areas.

Majority of the agro-producers sourced animal feeds (especially fodder) outside their homes. Whereas crop enterprises were practiced beyond the home boundaries, livestock and poultry enterprises were carried out within the home compound. This was associated with the high insecurity associated with livestock and poultry compared to crops although regular management required on animals could be a reason. During the study, it was observed that producers dried, sieved and fed poultry manure to cattle and pigs. Some producers indicated that they harvested rabbit waste (especially urine) and was a high value product but the claims could not be substantiated since some refuted them. Agro-food waste was also commonly boiled before feeding it to pigs. However, some producers indicated that they could not feed waste to their pigs since they had been contracted to supply pork to sausage manufacturers/processors who were against the practice. This notion could be associated with Choe et al. (2017) findings that pig fed on food waste had inferior meat quality although Márquez & Ramos (2007) had indicated that food waste has only minor effects on the carcass quality thus could be fed to pigs.

CONVENTIONAL INPUTS UTILISATION

In utilisation of other inputs (other than labour), the results indicated that livestock commercial feeds had the highest share of conventional inputs budget. During the three months period under consideration, urban agro-producers spent an average of Kes21,842.35 followed by fertilizer at Kes658.40. Expenditure on livestock veterinary services was estimated at Kes632.13 while fodder and pesticides were Kes576.14 and 574.60 respectively. Whereas a chunk of agro-producers did not spend on either one or more of these conventional inputs, livestock feeds recorded the highest upper expenditure at Kes480,000 while expenditure on other inputs had highs of under Kes50,000. The overall mean value of conventional inputs used in urban agro-producer households was estimated at Kes25,978.84. This translated to 73% of the total budget share for inputs used in urban agro-producer households. This is an indicator that agro-producers are largely inclined towards conventional inputs but with noteworthy contribution of agro-food waste in urban agriculture commercialization. During the survey, it was observed that there was a likely suboptimal level of production intensification. Therefore, enhanced support towards production intensification would be expected to propel agro-producers to transition to a higher level of agro-food waste commercialization.

Assessment of measurement model

Based on Hair *et al*. (2019)yet concise, overview of the considerations and metrics required for partial least squares structural equation modeling (PLS-SEM evaluation of the measurement model procedure, the results of the study revealed that indicator loadings of 0.691 to 0.927 were registered, as shown in Table 3. The assessment criterion advocates a minimum of 0.70 for indicator loadings which would imply acceptable level of reliability of the item under consideration. However, as a rule of thumb, Hair *et al*. (2019)yet concise, overview of the considerations and metrics required for partial least squares structural equation modeling (PLS-SEM indicated that a minimum of 0.60 indicator loading was a sufficient basis for gauging the reliability of the indicators and data generated thereof if it is not for confirmatory purposes. According to Chin (1998"abstract":"Provides a nontechnical introduction to the partial least squares (PLS) and Hair *et al*. (2019) yet concise, overview of the considerations and metrics required for partial least squares structural equation modeling (PLS-SEM, any indicator that does not meet the set criterion is considered unreliable, as such should be deleted. Therefore, discarding of indicators that did not meet the set criterion was implemented during the modelling process. As a result, some of the indicators of AT, EAC, RP, MT, PMO, CUI, CUB and CF constructs were dropped. Consequently, the overall explanatory power of model improved. The aforementioned loadings of the improved model were a pointer that more than 50 percent of the variance of the indicators could be explained. Hair *et al*. (2019)yet concise, overview of the considerations and metrics required for partial least squares structural equation modeling (PLS-SEM argued

1 The exchange rate at the time of the survey was KES107.707 = 1$USD

Table 2: Agricultural production, waste utilisation and sale of surplus produce among urban agro-producer households

	Production participation	Value of waste utilised				Value of produce sold			
		Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Vegetables	-	3,121.40	4,117.24	0	45,000.00	26,219.18	50,731.08	0	450,000.00
Kales	86%								
Amaranth	22%								
Spinach	60%								
Cabbage	23%								
Tomato	20%								
Pumpkin	33%								
Indigenous vegetables	55%								
Fruits	-	1,310.75	1,675.72	0	30,000.00	6,257.79	18,891.09	0	150,000.00
Banana	52%								
Other fruits	42%								
Legumes: Beans	55%	177.32	968.36	0	20,000.00	482.68	3,863.35	0	58,000.00
Cereals: Maize	64%	174.98	1,204.40	0	20,000.00	2,070.07	10,197.25	0	115,000.00
Tubers	-	24.52	163.47	0	2,700.00	1,640.57	16,077.68	0	270,000.00
Irish potatoes	25%								
Arrow root	19%								
Sweet potato	21%								
Fodder	38%	1,092.00	728.37	0	12,500.00	768.2	6,143.86	0	90,000.00
Livestock	-	2,438.16	12,524.24	0	200,000.00	40,012.57	99,038.94	0	1,000,000.00
Cattle	41%								
Goat/sheep	13%								
Pig	20%								
Rabbit	6%								
Poultry	54%					31,335.79	108,213.30	0	1,200,000.00
Tree and flower propagation	11%	1,385.02	16,682.67	0	350,000.00	18,782.89	78,471.77	0	600,000.00

that indicator loadings of 0.70 to 0.90 were evidence of 'satisfactoriness to goodness' of the indicators, as long as they were less than 0.95. Therefore, all the indicators used for the measurement model in agro-food waste commercial utilisation were reliable.

Although Cronbach's alpha and rho-A could have been used to check for internal consistency, composite reliability has been argued to be a better method given that it largely retains the standardized loadings of constructs (Fornell & Larcker, 1981). Composite approach has low sensitivity to variations and is considered to be compensatory unlike other methods of measuring internal consistency. The internal consistency of the measurement model using composite reliability (CR) indicated scores ranging from 0.698 to 0.890 (Table 3). The convergent validity of the constructs based on average variance extracted (AVE) indicated a range of 0.536 to 0.801. These indications revealed that the constructs used in modelling agro-food waste commercial utilisation model were acceptable since they had more than 0.50 scores. This implied that at least 50 percent of variance of the indicator items used could be explained by the constructs selected for the model (Hair et al., 2019). Therefore, convergent validity was attained for the study model.

Table 3: Construct reliability and validity

	Indicator	Mean	Std. Dev.	Indicator Loadings	CR	AVE
AT	at_1	4.353	0.833	0.751	0.792	0.656
	at_2	4.268	0.959	0.865		
CUI	bi_1	4.362	0.826	0.823	0.784	0.549
	bi_2	3.732	1.4	0.691		
	bi_3	3.967	1.2	0.703		
CF	cf_1	0.17	0.375	0.702	0.698	0.536
	cf_2	3.314	0.994	0.762		
EAC	eac_1	4.529	0.71	0.762	0.739	0.586
	eac_2	4.649	0.642	0.768		
MO	mo_1	4.279	0.982	0.808	0.825	0.611
	mo_2	4.215	0.949	0.768		
	mo_3	4.445	0.857	0.768		
MT	mt_1	3.996	1.16	0.889	0.890	0.801
	mt_2	3.939	1.232	0.901		
PBC	pbc_1	3.831	1.177	0.902	0.798	0.666
	pbc_2	3.351	1.467	0.721		
RP	rp_1	3.342	1.448	0.916	0.807	0.679
	rp_2	3.352	1.273	0.720		
SN	sn_1	3.642	1.273	0.874	0.838	0.722
	sn_2	3.307	1.071	0.824		
CUB	ub_1	3.342	1.448	0.927	0.882	0.790
	ub_2	3.908	1.185	0.849		

To establish the distinctiveness of the constructs adopted for the agro-food waste commercial utilisation model, the assessment of discriminant validity were implemented (Table 4). Based on Fornell-Larcker criterion that shared variance for all model constructs should not exceed their AVEs, the study results indicated that all the shared variances were smaller than their respective AVEs (diagonal). However, Henseler & Sarstedt (2013)namely goodness-of-fit indices. In order to illustrate the behavior of the goodness-of-fit index (GoF argued that Fornell-Larcker criterion was not a good measure for assessing discriminant validity since it is sensitive to slight indicator loading disparities. Therefore, to confirm the reliability of the current study findings the cross-loadings were assessed (Table 4). The cross loadings were comparably higher than the inter-correlations of the construct of all the other observed variables (Hussain, Fangwei, Siddiqi, Ali, & Shabbir, 2018) in the agro-food waste commercial utilisation model. This confirmed that the constructs adopted for the study model were discriminately valid.

Table 4: Fornell-Larcker criterion and cross-loadings

C/I*	AT	CF	CUB	CUI	EAC	MO	MT	PBC	RP	SN
AT	**0.810**									
CF	0.060	**0.732**								
CUB	0.289	0.178	**0.889**							
CUI	0.382	0.168	0.315	**0.741**						
EAC	0.343	0.197	0.320	0.403	**0.765**					
MO	0.270	0.148	0.523	0.370	0.359	**0.782**				
MT	0.431	0.186	0.600	0.446	0.359	0.594	**0.895**			
PBC	0.383	0.101	0.561	0.299	0.349	0.599	0.646	**0.816**		
RP	0.353	0.189	0.883	0.268	0.302	0.449	0.547	0.559	**0.824**	
SN	0.385	0.131	0.436	0.237	0.320	0.384	0.463	0.544	0.676	**0.850**
at_1	**0.751**	0.025	0.215	0.253	0.240	0.221	0.325	0.306	0.253	0.294
at_2	**0.865**	0.068	0.251	0.357	0.310	0.219	0.372	0.317	0.315	0.329
cf_1	-0.025	**0.702**	0.002	0.117	0.044	0.033	0.055	0.016	-0.010	-0.040
cf_2	0.107	**0.762**	0.247	0.129	0.236	0.177	0.211	0.127	0.275	0.220
ub_1	0.263	0.167	**0.927**	0.242	0.267	0.390	0.463	0.445	0.916	0.396
ub_2	0.252	0.148	**0.849**	0.337	0.315	0.577	0.641	0.582	0.612	0.382
bi_1	0.322	0.164	0.408	**0.823**	0.327	0.394	0.443	0.300	0.327	0.209
bi_2	0.282	0.057	0.037	**0.691**	0.280	0.139	0.266	0.145	0.045	0.135
bi_3	0.237	0.126	0.113	**0.703**	0.291	0.201	0.209	0.167	0.120	0.167
eac_1	0.270	0.175	0.342	0.299	**0.762**	0.320	0.337	0.284	0.314	0.283
eac_2	0.255	0.128	0.150	0.318	**0.768**	0.230	0.213	0.250	0.149	0.208
mo_1	0.222	0.088	0.520	0.292	0.271	**0.808**	0.582	0.561	0.455	0.350
mo_2	0.209	0.127	0.307	0.287	0.246	**0.768**	0.355	0.396	0.283	0.297
mo_3	0.201	0.135	0.386	0.290	0.332	**0.768**	0.443	0.436	0.300	0.245
mt_1	0.320	0.144	0.562	0.355	0.277	0.534	**0.889**	0.586	0.502	0.409
mt_2	0.449	0.189	0.514	0.441	0.364	0.529	**0.901**	0.570	0.478	0.421
pbc_1	0.306	0.108	0.594	0.220	0.266	0.549	0.619	**0.902**	0.585	0.504
pbc_2	0.340	0.047	0.263	0.295	0.330	0.417	0.406	**0.721**	0.274	0.369
rp_1	0.263	0.167	0.927	0.242	0.267	0.390	0.463	0.445	**0.916**	0.396
rp_2	0.361	0.149	0.433	0.199	0.235	0.361	0.461	0.521	**0.720**	0.714
sn_1	0.307	0.138	0.411	0.175	0.201	0.317	0.321	0.501	0.712	**0.874**
sn_2	0.289	0.069	0.300	0.204	0.317	0.288	0.317	0.395	0.407	**0.824**

***C/I refers to construct or indicators**

Evaluation of the Structural Model

Whereas the measurement model had been established to be reliable and valid, these aspects are not considered adequate in determining the suitability of a structural model (Hussain et al., 2018; Hair et al., 2019)yet concise, overview of the considerations and metrics required for partial least squares structural equation modeling (PLS-SEM. Therefore, structural assessments are requisite. According to Hussain et al. (2018), the assessment involve establishing the predictive relevancy and constructs relationship of the model. Often coefficient of determination (R2), goodness of fit index, path coefficients (), p-values/T statistics, effect size (f2) and the predictive relevance of the model indicators (Q2) are considered. In comparison, Hair et al. (2019)yet concise, overview of the considerations and metrics required for partial least squares structural equation modeling (PLS-SEM considered the

coefficient of determination (R2), the blindfolding-based cross-validated redundancy measure (Q2), and the statistical significance and relevance of the path coefficients portrayed by the constructs as the basis for assessing the structural conduct of a model.

Whereas the standard assessment criteria outlined by Hussain et al. (2018) and Hair et al. (2019) Structural Equation Modeling (SEMare critical, assessment of collinearity is important as well (Hair et al., 2019)yet concise, overview of the considerations and metrics required for partial least squares structural equation modeling (PLS-SEM before commencing the structural evaluation of the model. The results of the collinearity test indicated variance inflation factors range of 1.005 to 1.570 which meant that the model did not have collinearity problems (Becker, Ringle, Sarstedt, & Völckner, 2015). The R2 for the agro-food waste commercial utilisation behaviour was established to be 0.791 as shown in Table 5 and Figure 1. This implied that 79.1% of the commercial utilisation behaviour variance could be explained by the model's constructs. This would be considered substantial in-sample explanatory power for the behaviour depicted among urban agro-producer households. The R2 for PBC and CUI were second and third largest at 0.417 and 0.309 which indicated their strength in explaining the commercial utilisation behaviour variance was higher than the other constructs.

Bootstrapping procedure revealed the path coefficients as presented in Table 5 and Figure 1. Considering the H1a hypothesis, it was established that AT had significant and positive influence on CUI. As such, the hypothesis was supported. The findings implied that household attitudes were critical in forming intentions towards agro-food waste commercial utilisation considerations. As such positive attitudes were expected to contribute to increased agro-food waste commercialization intentions. The findings coincided with those of Ayob, Sheau-Ting, Abdul Jalil, & Chin (2017) subjective norm (SN towards waste separation intention among students in Malaysia. Heidari et al. (2018)Iran, using questionnaires, and analyzed by cluster analysis, discriminant analysis and structural equation modelling techniques (SEM showed similar findings towards waste separation at source in Iran. Similarly, hypothesis H1b was supported based on the positive and significant effect of AT on RP. The findings implied that the overall attitude of agro-producer households towards agro-food waste commercialization had a stake in the level of risk perception towards waste utilisation. Williams & Noyes (2007)risk perception can be understood as an individual's assessment of risk, and the adequacy of any risk assessment is reliant on the adequacy of the accessible risk information. Consequently, one way to understand the effect of risk perception on decision-making, and the approach taken in this literature review, is to understand how risk information is communicated and received by an individual. A number of factors are identified that have been found to influence perceptions of risk, which are related to the design of risk messages: the message (colour, signal word, surround shape, and the framing effect also noted that attitudes had effect on trust, risk perception and the likelihood of information acceptance. As such increased positivity in attitude towards agro-food waste utilisation would alter their level of risk perception.

Table 5: Path coefficients

Hypothesis	Path	Coefficient	Standard Deviation	T Statistics
H1a	AT -> CUI	0.204**	0.051	4.023
H1b	AT -> RP	0.353**	0.043	8.276
H2	SN -> CUI	-0.041	0.058	0.700
H3a	PBC -> CUI	-0.091	0.064	1.431
H3b	PBC -> CUB	0.083*	0.035	2.340
H4a	RP -> CUB	0.818**	0.020	40.027
H4b	RP -> CUI	-0.015	0.072	0.203
H5a	EAC -> AT	0.343**	0.045	7.558
H5b	EAC -> CUI	0.223**	0.051	4.346
H6a	MT -> PBC	0.646**	0.033	19.832
H6b	MT -> CUI	0.267**	0.077	3.457
H7a	MO -> SN	0.384**	0.038	10.057
H7b	MO -> CUI	0.144*	0.073	1.979
H8	CUI -> CUB	0.071*	0.028	2.534
H9	CF -> CUI	0.058	0.042	1.399

***5% significance and **1% significance**

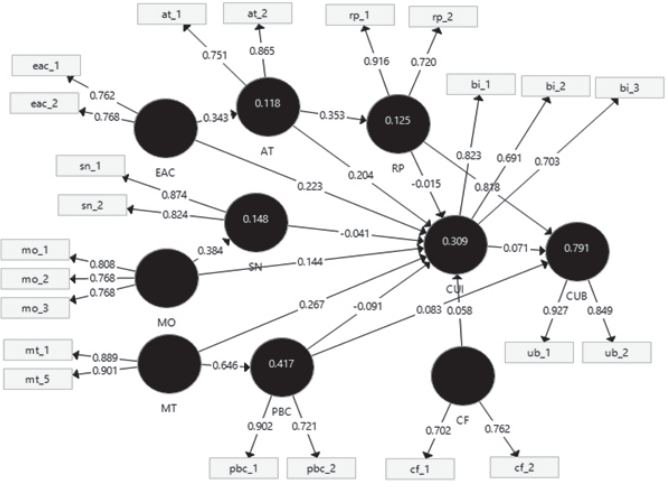

Figure 1: Indicator/factor loadings and path coefficients

Hypothesis H2 and H3a showed insignificant effects of both SN and PBC on CUI thus they were rejected. The findings contradicted with Ayob *et al.* (2017)subjective norm (SN on the PBC aspect but coincided with the insignificant effect of SN on CUI. This study findings went against Ajzen (1985, 1991) projections that PBC and SN were likely to influence behavioural intentions. Nystrand & Olsen (2020) with an extension of self-efficacy and descriptive norms and, as well, hedonic and utilitarian eating values, is used as a conceptual framework. Structural equation modeling (SEM also established insignificant association between PBC and

intention towards consuming functional foods. The H3b hypothesis was confirmed by the positive significant effect portrayed by PBC on CUB. This implied that PBC of the agro-producer household influenced the agro-food waste commercial utilisation behaviour but not its intentions. Similar PBC and CUB association was also established in Heidari et al. (2018)Iran, using questionnaires, and analyzed by cluster analysis, discriminant analysis and structural equation modelling techniques (SEM in source separation of waste intention and behaviour.

Hypothesis H4a showed significant influence of RP on CUB although it was not negative as it was expected. However, this may imply that farmers who had higher level of risk perceptions were likely to form commercial utilisation behaviour. This may also be interpreted as increased interest in agro-food waste as a supplementary input in urban agriculture would likely establish higher inherent risk issues but agro-producers would address them and utilise it due to expected benefits. This path also had the highest effect towards the commercial utilisation behaviour of agro-food waste. This meant that RP had the topmost influence on the ultimate decision to commercialize using agro-food waste. Kummeneje & Rundmo (2020)risk perception, worry, risk tolerance, safety priority, and accident involvement are associated with cyclists' risk-taking behaviour. Two types of cyclists' risk-taking behaviour were studied: (1 findings indicated that risk perceptions among cyclists in Norway had influence on their traffic behaviour. However, RP had negative but insignificant influence on CUI.

EAC relationships with AT and CUI indicated strong positive significant association. The results supported hypothesis H5a and H5b. The association indicated that the agro-producer awareness and concern towards the environment had a stake in determining the household's attitude on agro-food waste commercialization. The findings were similar to those of Li et al. (2019) that both environmental concern and environmental knowledge had significant influence on attitude towards purchase of energy efficient appliances. The EAC as well affected the intentions of commercial utilisation of waste. This may have implied that agro-producer households considered commercial utilisation of agro-food waste as a strategy of managing likely negative environmental effects while tapping the benefits. Li et al. (2019) also established a positive influence of environmental knowledge on intention to purchase. Further, the t-statistic of the path coefficients showed significant positive influence of agro-producer households' MT on their perceived ability to control the commercial aspect of agro-food waste as well as the intentions to commercialize. This meant that motivation among household members in utilising agro-food waste beneficially from a commercialization aspect was important in developing the overall behaviour. Similarly, Ajzen (2012) and Johansson (2016)waste volumes are increasing rapidly and the World Bank estimates a 70% global increase in municipal solid waste up to 2025. Waste may have serious environmental consequences and there is a strong correlation between solid waste generation rates and greenhouse gas emissions. These two observations alone indicate that this development is not sustainable. Recycling is one of the most important actions currently available to reduce the environmental impact of waste. While, waste recycling in OECD countries is reported to be approximately 22% on average, many developing countries have recycling rates in the range of 1–3%. A key aspect in succeeding with any recycling effort is how authorities and other actors relate to both informal and formal waste workers. This paper reports on the findings of a systematic literature study with the aim of exploring waste recycling behavior, with a special focus on motivational factors, both physical and psychological, behind recycling. Three levels of descending importance for recycling have been identified, where two are vital for success, and the third is desirable; 1 associated motivation to development of behavioural intentions.

MO of the urban agro-producer households had positive significant effect on SN and CUI. This implied that MO influenced the social pressures as such MO of an individual household was likely to be diffused to other households who would embrace it as a norm thus becoming part of the SN in a community/society. MO also initiated the inner push of agro-producer households in developing the commercial utilisation intentions for agro-food waste. This was a confirmation for the hypotheses H7a and H7b. Similarly, software piracy intentions were shown to have positive relationship with perceived moral obligation (Hashim, Kannan, & Wegener, 2018).

CUI had positive significant influence on CUB. This indicated that once an agro-producer household developed intentions to commercialize agricultural production using agro-food waste then they were likely to end up commercializing. This implies once urban agro-producer households developed agro-food waste commercialization intentions, they were likely to transition to actual commercialization. The association was supported by Foltz, Newkirk, & Schwager (2016) findings that the intention towards amending social networking security credentials influenced the ultimate behaviour.

The blindfolding-based cross-validated redundancy measure (Q^2) results were as presented in Table 6. Application of the rule of thumb as suggested by Hair et al. (2019)yet concise, overview of the considerations and metrics required for partial least squares structural equation modeling (PLS-SEM showed that the adopted constructs were relevant in their predictive accuracy of the structural model. The relevance ranged from small to large as shown in Table 6.

Table 6: Construct Cross-validated Redundancy

Construct	Q^2	Predictive relevance
AT	0.074	Small
CUB	0.601	Large
CUI	0.146	Small to moderate
PBC	0.268	Moderate
RP	0.088	Small
SN	0.103	Small to moderate

The specific indirect effects of the commercial utilisation model were as shown in Table 7. The coefficients are indication

of the mediation role played out by various constructs in the model.

Table 7: Specific indirect effects

Path	Coefficient	Std. Dev.	T Statistics
AT -> CUI -> CUB	0.014*	0.006	2.478
EAC -> AT -> CUI -> CUB	0.005*	0.002	2.485
CF -> CUI -> CUB	0.004	0.003	1.186
EAC -> CUI -> CUB	0.016*	0.006	2.464
MO -> CUI -> CUB	0.010	0.008	1.354
MT -> CUI -> CUB	0.019	0.010	1.821
PBC -> CUI -> CUB	-0.006	0.005	1.259
MT -> PBC -> CUI -> CUB	-0.004	0.003	1.265
RP -> CUI -> CUB	-0.001	0.005	0.201
AT -> RP -> CUI -> CUB	0.000	0.002	0.200
EAC -> AT -> RP -> CUI -> CUB	0.000	0.001	0.196
SN -> CUI -> CUB	-0.003	0.005	0.582
MO -> SN -> CUI -> CUB	-0.001	0.002	0.572
MT -> PBC -> CUB	0.053*	0.024	2.239
AT -> RP -> CUB	0.289**	0.034	8.565
EAC -> AT -> RP -> CUB	0.099**	0.020	4.928
EAC -> AT -> CUI	0.070**	0.019	3.759
MT -> PBC -> CUI	-0.059	0.041	1.436
AT -> RP -> CUI	-0.005	0.026	0.200
EAC -> AT -> RP -> CUI	-0.002	0.009	0.195
MO -> SN -> CUI	-0.016	0.023	0.686
EAC -> AT -> RP	0.121**	0.025	4.825

****significant at 1% and *significant at 5%**

CONCLUSION

The study had sought to understand what drives agro-food waste commercial utilisation intention and its transition to behaviour. First, descriptive analysis of production participation across numerous enterprises, utilisation of agro-food waste as well as the produce sales was conducted. The results indicated high production participation in Kales enterprise although the highest use of agro-food waste was recorded in vegetables while the highest produce sales were in tree and flower propagation enterprise. Higher expenditure share was recorded for conventional inputs (73%) compared to agro-food waste (27%). In order to explore what drove commercial utilisation, validity and reliability procedures and conduct of the adopted model were carried out. Results indicated requisite validity and reliability of the indicators used to build constructs. The model's in-sample explanatory power was substantial as well as its predictive accuracy and relevance. The resultant structural model path coefficients indicated that attitude, environmental awareness and concern, motivation and perceived moral obligation had positive significant influence on commercial utilisation intention. Furthermore, commercial utilisation intentions, risk perceptions and perceived behavioural control had significant influence on the commercial utilisation behaviour. This implied that the commercialization intentions formed in an urban agro-producer household were likely to transition to agro-food waste commercial utilisation behaviour. A further implication is that if small-urban farm businesses could be empowered through agro-food waste management and utilisation programs, they would likely develop interest in commercial utilisation of waste and may result to actionable commercialization.

Limitations and suggestions for further research

There was a considerable challenge in attaching value to agro-food waste. In some cases, the value attached to waste was the price associated. Considering this was not the real value for waste, better methodological basis could be employed, the utility of waste could be factored in.

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APPENDICES

Constructs used in the SEM model

Variable	Mean	Standard deviation	Minimum	Maximum
Attitude	3.6826	0.4260	1.7143	4.8571
Subjective norm	3.3246	0.9989	1.0000	5.0000
Perceived behavioural control	3.3757	0.8901	1.6667	5.0000
Environmental awareness and concern	4.4531	0.5041	2.4000	5.0000
Moral obligation	4.1488	0.6203	1.1667	5.0000
Motivation	4.0031	0.7548	1.2000	5.0000
Commercial intentions	4.1201	0.7360	1.7500	5.0000
Commercial utilisation behaviour	2.5892	0.7145	1.0000	5.0000
Risk perceptions	2.3118	0.5612	1.1667	4.1667