Demand-Supply Matching Platform of GAP Vegetables Between Modern Trade and Hospital Matching with Community Enterprise: A Collaborative Brainstorming to Agribusiness Development

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Abstract

Vegetable production in response to consumer needs is a challenge that involved sectors needing to work in concert to address. The study entitled the agribusiness development by collaborative brainstorming for the development of a demand-supply matching platform (DSMP) of good agricultural practices (GAP) vegetables between modern trade and hospital matching with community enterprises in Roi Et Province was conducted during the period July 2020 to September 2022 The findings as cognitive information demonstrated that all parties accepted each other's proposition; as a result, that led to the creation of the platform with fairness and balance between demand and supply. The developed platform consisted of four sub-platforms. The first one is Kham Pha-Ung Vegetables Community Enterprise (KPUVCE) x Their farmer network is a collaborative platform of the supply sector and serves to produce vegetables to the specified quantity and to manage production risks. Another named KPUVCE x Hospital is a direct order matching platform between KPUVCE and a hospital with a short credit term. The third one referred to as KPUVCE x Subcontract of modern trade (middleman) is an indirect order matching platform between KPUVCE and modern trade through a subcontractor of modern trade to relieve the limitations of a long credit term of modern trade paid to KPUVCE with inadequate working capital for management; the subcontract of modern trade pays cash or offers a short credit term to farmers. The final one, KPUVCE x Extension sector x Modern trade x Hospital is a collaboration promotion platform. As a result, it was found that KPUVCE could increase vegetables for modern trade and hospitals by 85% on average, and only 15% which is a challenge to DSMP balance.

Keywords: Participatory development, Agricultural development, Agricultural extension

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Introduction

Vegetables are vital nutrients for humans rich in vitamins, minerals, and fiber as well as serving food security and health. They are also determined as one of the sustainable development goals of the United Nations, for certain parts of the globe are still encountering a shortage of vegetables for consumption. In fact, the world's most important sites of vegetable production are East Asia and Southeast Asia with a vegetable yield of 574.4 and 45.6 tons per year respectively. In spite of this, it does not fulfill the world's needs with only 390g per person per day (FAO, 2020). The World Health Organization (WHO) recommends daily consumption of a minimum of 400g of vegetables per person and notes that the appropriate intake is dependent on different factors, such as age, gender, and exercise (WHO, 2019). The average daily vegetable intake among Thais is 135.34g per person which is lower than the world's mean (FAO, 2022). Thailand's vegetable cultivation area covers approximately 1.8 million rai and provides a yield of 2.6 million tons in total (Kim, *et al.*, 2019)

However, consumers have become more aware of residues in food. Additionally, Thailand's government has established a policy for Thai farmers to practice organic agriculture (Chareonpanich and Vongurai, 2018) and has promoted the production of organic or chemical-free vegetables to satisfy the needs of markets, especially urban markets since the cultivation of vegetables in urban and suburb areas has certain limitations, including pollution risks and the loss of high-value land to urban growth (Aubry and Manouchehri, 2019; Taguchi and Santini, 2019)

Production of quality vegetables is defined as vegetable production (or green product) according to Good Agricultural Practices (GAP) standards (Kyriacou and Rouphael, 2017) and GAP is a first step for the reduction of the use of agrochemicals in vegetable farming before advancing further to conduct organic farming (Supapunt, Intanu and Chaikampun, 2021). Hence, the capability to efficiently manage technical and organizational change becomes crucial to vegetable farmers (Ofuoku, and Ogisi, 2020). In such production, engaging producers as a supplier to match the demand of the consumer market can ensure that farmers' production of vegetables and the consumer market are aligned, essentially producing fruitful outcomes for both parties. Moreover, the GAP vegetables as food quality and perceived value showed a significant influence on customer satisfaction (Praditbatuga, Treetipbut. and Chantarak, 2022).

Production of vegetables in response to consumer needs necessitates forming a production network. Additionally, a common practice to link demand and supply in local areas or provinces between producers and consumers to produce agricultural products in perfect response to demand is the development of platforms for stakeholders as a learning hub and a place for collaboration on agricultural development (Dror, *et al.*, 2016). It serves as the beginning of the cooperation between the public and private sectors (Schut, *et al.*, 2017). Drawing a conclusion on an effective platform requires cooperation among stakeholders at the village or community levels (VanRooyen, *et al.*, 2017). A platform in a local area may be able to solve concrete agricultural issues; however, without being linked to the authorities at a higher level, it is unlikely to be able to promote or achieve structural changes at a higher level (Lamers, *et al.*, 2017).

An initial study showed that in Thailand, there have been successful models in various areas. As in the case of modern trade matching with farmer group, the Doi Rai Plai farmers in Mueang district, Chiang Rai Province, produced organic vegetables for Chiangrai Prachanukroh Hospital while the Hug Nam Jang farmers' group in Mae Tha district, Lampang Province, did that for Lampang Hospital (Thongkam and Sasananan, 2014) and the Ban Don Satan farmer group in Pua district, Nan Province, they vegetables produce for hospitals (Thamchinda *et al.*, 2017).

In relation to the case of hospitals matching with the farmer group, the Ban Sawang Sam Ong farmer group in Sam Sung district produced GAP vegetables for Top Supermarket (Central Group)), and the Ban Non Khawao vegetable farmers in Mueang district, Khon Kaen Province, did that for Lotus Supercenter (Utaranakorn *et al.*, 2019). In some area such as Phetchabun province, promotion of vegetable production of the Green Market Phetchabun farmer group for modern trade (Sukhonthasing, 2019)

Taking that into account, Roi Et Provincial Hall (Governor's office) conceived of a development initiative that determined that the development of food safety was to be carried out through the development of the Demand-Supply Matching Platform (DSMP) of GAP vegetables (or GAP vegetables). As specified in Roi Et's Development Strategic Plan (2018 to 2022), Roi Et Agricultural Extension Office was appointed to be in charge. Thus, Roi Et Agricultural Extension Office integrated the province's development strategic plan with development strategies on area-based agricultural extension and collaborative farming of the Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, which is the supervising body of the Roi Et Agricultural Extension Office.

As discussed above, it posed a challenge to carry out the project entitled the local agribusiness development of a DSMP of GAP vegetables with the intention of addressing the question of what can be done to ensure the balance of demand and supply in the producer-consumer matching platform. The findings could create job opportunities for farmers, form a network, and allow them to earn yearly earnings, and consumers living in urban areas can consume GAP vegetables. Finally, the findings could serve as a model for development in other areas.

Methods

Moazed and Johnson (2016) outlined the perspectives on Modern Monopolies: What It Takes to Dominate the 21st Century Economy and they explained how to platform building in four sections including (1) audiences building, (2) rules and standards, (3) matching and (4) tools and services. However, in order to be consistent with the context of this DSMP development, the method of Moazed and Johnson (2016) above has been applied by adding a step of DSMP development to six phases, each phase operates by using stockholders' brainstorming collaborative for development as same as participatory action research technique (PAR) (Borisutdhi, 2015), including (1) audiences building, (2) understanding rules and standards (3) rules and standards, (4) matching, (5) tools and services building and (6) after-action review on social impacts or changes. Phases 1 to 5 are conducted during the period July 2020 to October 2021 and phase 6 was completed from October 2021 to

September 2022. Specifically, it consisted of six phases as detailed below.

Phase 1 Audiences building: The operation of this phase entailed inviting relevant stakeholders; Kham Pha-Ung Vegetables Community Enterprise (KPUVCE), modern trade stores, and hospitals ready to participate in the project. In the very first stage, unofficial cooperation was initiated to approach all stakeholders, followed by official cooperation.

Phase 2 Gap analysis of the demand-supply: This phase was a gap analysis of the demand-supply of GAP vegetables by involved creating sub-topics for collecting secondary data from relevant documents and primary data through observation, in-depth interviews, and focus group discussions in order to address the question regarding the gap of demand and supply of GAP vegetables among concerned stakeholders, namely KPUVCE, modern trade stores, and hospitals.

Phase 3 Understanding rules and standards: This phase concerned analyzing all stakeholders' propositions and conditions to comprise rules and standards in the order to reach negotiations that would be mutually beneficial. In particular, findings from Phase 1 were drawn on to create sub-topics for collecting the data by means of observation, in-depth interviews, and focus group discussions so as to provide insight into propositions and conditions from all parties to reach negotiations which would benefit all involved stakeholders, including KPUVCE, modern trade stores, and hospitals.

Phase 4 Matching: It involved matching the committee of KPUVCE with directors of modern trade stores and hospitals to build rapport. The results from Phases 1 and 2 were based on determining sub-topics as a tool for organizing a forum or an activity in which KPUVCE, modern trade, and hospitals were matched; negotiations were held for each pair at different periods.

Phase 5 Tools and services building: The final phase entailed supplying tools and services. In particular, a promise among concerned stakeholders was made to provide tools and services in order to ensure fairness and balance between demand and supply. In implementing this phase, the results of all prior phases ranging from Phase 1 to Phase 3 were drawn on to create sub-topics to hold a forum, an activity, and a focus group discussion on tools and services building for social enterprises, modern trade stores, hospitals and relevant agencies.

Phase 6 Pilot running and after-action review: After the DSMP has been done were pilot running in the short term and conducting an after-action review (AAR) by organizing a brainstorming discussion to assess the social impacts or changes as a short-term finding of the development.

Results and Discussions

The findings as cognitive information found that.

Phase 1: Audience Building

This phase was implemented during the period July to November 2020 by invitations and setting of relevant stakeholders (preparation before development). The developed platform was a structural-functional platform for all concerned stakeholders. To ensure the flow of the development and objective achievement, the extension sector, including Roi Et Provincial Hall (Governor's office) and Roi Et Agricultural Extension Office as an organizer and a facilitator in the development of DSMP of GAP vegetables, cooperated with the relevant sectors in preparation for the development. Consequently, the following sectors agreed to engage in the development.

1. Demand sector: The consumer market represented vegetable demand. Those agreeing to take part in the project are listed below.

1.1 Modern Trade: (1) TM-MT (pseudonym) is a modern trade supermarket as a flagship store for vegetables, fruits, and fresh food; it is responsive to the needs of people in urban areas and the lifestyles of a new generation of families and people. (2) LR-MT (pseudonym) and BR-MT (pseudonym) are modern trade hypermarket that features different sections. The section of fresh food, vegetables, and fruits procures fruits from farmers and vegetable trading companies directly and has them sold in their stores. It is aimed at providing mid-tier customers with a variety of quality products at affordable prices. (3) A subcontractor of modern trade (middleman) was the last to join this project. The results demonstrated that all stores mentioned earlier did not purchase vegetables from producers directly. Instead, two private companies were responsible for procuring vegetables for the stores. Specifically, KWKK (pseudonym) is a wholesaler of agricultural raw materials to modern trade stores; it serves as a supplier that procures produce from farmers and distributes it to LR-MT. Similarly, KK Farm (pseudonym) is a wholesaler of agricultural raw materials to modern trade stores; it acts as a supplier that purchases produce from farmers and distributes it to TM-MT and BR-MT. These companies helped facilitate management.

1.2 Hospital: Two hospitals agreed to participate in the project; (1) ROI-H (pseudonym) is an A-level healthcare facility with 915 beds for patients. Its payment for GAP vegetables is made to sellers according to the quantity specified in each

purchase order and a unit price within 30 days starting from the date they present evidence of receipt of supplies from the hospital. The second hospital, (2) PHO-H (pseudonym) is an F2-level healthcare facility with 30 beds for patients. It procures GAP vegetables from farmers and farmer groups for its patients in compliance with the food safety hospital policy.

2. Supply sector: The farmer sector as vegetable suppliers was KPUVCE and their farmer networks. KPUVCE has 53 members. Most areas of vegetable production are public areas under the responsibility of Kham Pha-Ung Sub-district Municipality. The municipality allocates 1 Ngan of cultivation areas to each farmer holding membership of KPUVCE, collects rental fees, and installs a water meter. KPUVCE has three networks of GAP vegetable production as follows: 1) the farmer network in Don Ong sub-district, Pho Chai district, Roi Et Province; 2) the farmer network in Phosri sub-district, Pho Chai district, Roi Et Province; and 3) the Ban Na Paeng farmer network in Naudom sub-district, Phon Thong district, Roi Et Province.

3. Extension sector: The Roi Et Agricultural Extension Office was appointed by Roi Et Provincial Hall (Governor's office) as an organizer and a facilitator; the budget allocated for the operation amounted to 7.4 million Thai Baht (THB) (approximately 36 THB = 1 USD).

The audience or stakeholder building shows that farmers, businesses, and governments (as three sectors: people-private-public (PPP) collaborative development) are ready and willing to participate in the development of the DSMP. This finding is consistent with Ngatindriatun and Adzim (2022) reported that the efforts to empower agribusiness-based farmers with a sustainable integrated farming system approach in the community require collaboration and synergy from various stakeholders to achieve the desired goals.

Phase 2: The gap of Demand-Supply of GAP Vegetables

This phase was implemented during the period August to November 2020. The extension sector conducted a gap analysis and uncovered several key points. The findings demonstrated that the gap between all demand and supply (general and GAP vegetables) was more than -84.10% on average and it was found that (1) in the demand sector (modern trade and hospitals), (1.1) modern trade (TM-MT, LR-MT and BR-MT) had a high level of demand for vegetables during the Chinese New Year (February) and the Vegetarian Festival (October) (Table 1). (1.2) Hospitals (ROI-H and PHO-H) had a high level of demand for vegetables from June to September since the hospitals were flooded with a considerable number of patients suffering with a fever of unknown origin, dengue fever, and influenza during this period (Table 1). Apart from that, it was discovered that (2) the supply sector (KPUVCE) had the potential to produce certain types of vegetables demanded by the markets and was less interested or had no intention of cultivating some types of vegetables, namely Chinese cabbage, cabbage, cauliflower, broccoli, and green cabbage (Table 1).

The results demonstrated that farmers were less interested or had no intention of cultivating certain types of vegetables, including Chinese cabbage, cabbage, cauliflower, broccoli, and green cabbage. This phenomenon can be explained by the fact that the purchase prices of produce tended to fluctuate according to the marketing mechanism; moreover, these types of vegetables had a high production cost, and the farmers were not motivated as well as encountering problems in production as in climate change and too high temperatures for their head formation. This finding is consistent with Tisa and Kumchai (2022)'s study which found that cruciferous vegetables prefer cool weather to stimulate head formation, and they can be produced in the lowlands of Thailand only during winter. It is also akin to Mahathanaset and Pensupar (2020)'s study which stated that the importation of cruciferous vegetables with the tendency to increase would result in a decline in farmland prices and supply of these vegetables in the country. Moreover, this finding is consistent with Bhaskaran and Thaiyalnaki (2022)'s study which found that consumers are highly aware of all the green marketing products available to them. The most preferred reason for green marketing products is the health benefits, environmental issues and pollution-free production. Consumers prefer green marketing products and sustainability for a cheap price so that they can systematically transfer from the traditional market to the green product markets. Similarly, Getprom *et al.* (2022) reported that consumers who are more concerned about their health will pay more attention to choosing safe and standardized agricultural products. Dhanashree and Vetrivel (2022) report that the consumer's environmental values have a positive influence on their perception of green products and similarly, consumers' environmental value has a positive influence on their green product purchase behavior.

However, the challenge in the current economic climate, customers are more likely to make a change if they can see a clear financial benefit from doing so (Nachappa and Sharma, 2022). Thus, KPUVCE and their farmer networks

should be urged to enhance the potential to produce vegetables in response to the needs of the markets, especially types of vegetables in short supply during each season.

Table 1. The gap of demand-supply of GAP vegetables in 2020

Date	Demand (Ton)												Supply (Ton)	The gap between all demand and supply (General and GAP vegetables)	The gap between the GAP vegetables demand requested and the supply from KPUVCE
	Modern trade						Hospital				All total demand (General and GAP vegetables)	Total of GAP vegetables demand requested from KPUVCE	KPUVCE (GAP vegetables)		
	TM-MT		LR-MT		BR-MT		ROI-H		PHO-H						
	All Demand (General and GAP vegetables)	GAP vegetables demand requested from KPUVCE	All Demand (General and GAP vegetables)	GAP vegetables demand requested from KPUVCE	All Demand (General and GAP vegetables)	GAP vegetables demand requested from KPUVCE	All Demand (General and GAP vegetables)	GAP vegetables demand requested from KPUVCE	All Demand (General and GAP vegetables)	GAP vegetables demand requested from KPUVCE					
Jan. 2020	42.30	never	31.15	never	25.47	never	43.23	12.97	0.14	0.14	142.29	13.11	26.45	**-81.41**	**n.a.**
Feb. 2020	64.30	never	42.60	never	36.70	never	43.23	12.97	0.13	0.13	186.96	13.10	31.48	**-83.16**	**n.a.**
Mar. 2020	46.70	never	32.09	never	27.11	never	44.30	13.29	0.13	0.13	150.33	13.42	27.34	**-81.81**	**n.a.**
Apr. 2020	48.20	never	34.28	never	29.53	never	42.40	12.72	0.11	0.11	154.52	12.83	26.19	**-83.05**	**n.a.**
May. 2020	52.10	never	39.20	never	33.71	never	37.87	11.36	0.12	0.12	163.00	11.48	23.72	**-85.45**	**n.a.**
Jun. 2020	49.75	never	34.30	never	30.45	never	49.37	14.81	0.12	0.12	163.99	14.93	23.12	**-85.90**	**n.a.**
Jul. 2020	48.20	never	36.07	never	31.20	never	49.50	14.85	0.25	0.25	165.22	15.10	23.27	**-85.92**	**n.a.**
Aug. 2020	51.45	never	38.48	never	33.11	never	40.00	12.00	0.25	0.25	163.29	12.25	22.60	**-86.16**	**n.a.**
Sep. 2020	45.25	never	36.36	never	31.04	never	49.57	14.87	0.20	0.20	162.42	15.07	23.88	**-85.30**	**n.a.**
Oct. 2020	69.05	never	47.01	never	40.50	never	37.77	11.33	0.16	0.16	194.49	11.49	32.41	**-83.34**	**n.a.**
Nov. 2020	49.06	never	37.55	never	32.20	never	35.90	10.77	0.14	0.14	154.85	10.91	24.17	**84.39**	**n.a.**
Dec. 2020	45.60	never	31.28	never	32.90	never	37.23	11.17	0.13	0.13	147.14	11.30	24.61	**-83.27**	**n.a.**
Total	**611.96**	**0.00**	**440.37**	**0.00**	**383.92**	**0.00**	**510.37**	**153.11**	**1.88**	**1.88**	**1948.50**	**154.99**	**309.24**	**-84.10**	**n.a.**

Phase 3: Understanding rules and standards

The extension sector drew on the results from Phase 1 to explore rules and standard propositions of demand and supply. This phase was conducted during the period from January to February 2021. The results are presented below.

1. Demand sector (Modern Trade and Hospital): It was discovered that **(1.1) modern trade** had three similar propositions, namely (a) transformation of growth profit (GP) into market share, (b) payment of credit a term after receipt of products, and (c) transformation of the distribution center (DC) into a market share in case there was no vehicle to transport vegetables to the distribution center (Table 2). Also, **(1.2) hospitals** shared two propositions as follows: (a) suppliers should be the bidder of their own vegetables to enter into e-bidding, and (b) payment of a credit term originally set to be within 30 – 45 days was requested to be made within 30 days among farmers producing vegetables for hospitals as a result of the delayed procurement (Table 3).

2. Supply sector (KPUVCE and their farmer networks): Its strength was vegetable production according to GAP standards (or GAP vegetables) and this DSMP project were an opportunity to sell their vegetable to modern trade and hospital. As a result, consumers and producers were paired to meet each other. Issues to be discussed to reach an agreement were (a) a short credit term of 30 days, (b) purchase through a middleman, (c) vegetable greenhouse development, and (d) development of vegetable packing houses.

Table 2 Understanding rules and standards

Paired	Demand	Supply	Matching Goals
1	**LR-MT mall** • Supplier can set a price that is not too expensive. • Must pay for the Growth Profit (GP) to Modern Trade. • Credit Term 15 – 30 days • Must pay for the Distribution Center (DC) to Modern Trade if there is no delivery vehicle to the distribution center. • LR-MT mall has an agreement with two suppliers: farmers in Khon Kaen province and KWKK company. If farmers want to sell vegetables to modern trade, it is recommended to sell them through supplier.	**KPUVCE** • Average Capacity 0.84 Tons per day (Only A and B grade vegetables) • Cash flow for just 3 months • Produce vegetables directly to Modern Trade • Increase the network, increase the production capacity.	• Negotiate with KWKK company (Supplier of LR-MT mall) to find a deal to resolve the problem of the product specification required by Modern Trade. And production planning to provide sufficient output to meet demand.
2	**TM-MT mall** • Supplier can set a price that is not too expensive. • Must pay for the Growth Profit (GP) to Modern Trade. • Credit Term 15 – 30 days • Must pay for the Distribution Center (DC) to Modern Trade if there is no delivery vehicle to the distribution center. • The sale of vegetables to Modern Trade must be verified by the Purchasing Section. And must try to sell products to Modern Trade for a period of 3 months for consideration of the operating results first.	**KPUVCE** **Potential:** • Average Capacity 0.84 Tons per day (Only A and B grade vegetables) • Cash flow for just 3 months • Produce vegetables directly to Modern Trade • Increase the network, increase the production capacity.	• Negotiate with TMMT mall to find a deal to direct product sales. • If farmers still cannot produce vegetables for sale directly to TMMT mall should negotiate with KK farm (Supplier of TMMT mall) to find a deal to resolve the problem of the product specification required by Modern Trade. And production planning to provide sufficient output to meet demand.
3	**BR-MT mall** • Supplier can set a price that is not too expensive. • Must pay for the Growth Profit (GP) to Modern Trade. • Credit Term 15 – 30 days • Must pay for the Distribution Center (DC) to Modern Trade if there is no delivery vehicle to the distribution center. • BR-MT mall has an agreement with KK farm. If farmers want to sell vegetables to modern trade, it is recommended to sell them through the supplier.	**KPUVCE** • Average Capacity 0.84 Tons per day (Only A and B grade vegetables) • Cash flow for just 3 months • Produce vegetables directly to Modern Trade	• Negotiate with KK Farm (Supplier of BR-MT mall) to find a deal to resolve the problem of the product specification required by Modern Trade. And production planning to provide sufficient output to meet demand.

Paired	Demand	Supply	Matching Goals
4	**ROI-H hospital** • Supplier can set prices of products for access to the e-bidding every quarter of the fiscal year. The price passed the deal will remain constant throughout the quarter. And the price will change when entering the new quarter. • Credit Term 30 – 45 days • Supplier must deliver products to the hospital kitchen each time before 7:30 a.m.	**KPUVCE** • Average Capacity 0.84 Tons per day (Only A and B grade vegetables) • Cash flow for just 3 months • ROI-H Hospital should resolve credit term issues for no more than 30 days. • Increase the network, increase the production capacity.	• Negotiate with ROI-H Hospital to find a deal to resolve the productivity problem that the hospital needs during the high volume of Inpatients Admission and late Credit Term problems.
5	**PHO-H hospital** • Supplier can set prices of products for access to the e-bidding every quarter of the fiscal year. The price passed the deal will remain constant throughout the quarter. And the price will change when entering the new quarter. • Credit Term 30 – 45 days • Supplier must deliver products to the hospital kitchen each time before 9:00 a.m.	**KPUVCE** • Average Capacity 0.84 Tons per day (Only A and B grade of vegetables) • Cash flow for just 3 months • PHO-H Hospital should resolve credit term issues for no more than 30 days. • Increase the network, increase the production capacity.	• Negotiate with PHO-H Hospital to find a deal to resolve the productivity problem that the hospital needs during the high volume of Inpatients Admission and late Credit Term problems.

Regarding rules and standards, it was noticeable that modern trade and hospitals had different propositions about the purchase of vegetables which were influenced by their directors. Each had its own policy to procure vegetables. Specifically, some purchased produce from farmers directly, which enabled farmers as producers to access a place for product distribution. Having a variety of business partners at play led to commercial competition, and the products were in turn purchased at a lower price. This finding complies with Sukhonthasing's study (2019) which stated that to distribute produce to modern trade, farmers as a producer must be ready to face any pressure. That is, some may procure vegetables from farmers directly, and certain companies as a middleman procure produce from farmers and distribute them to modern trade, while some others may purchase vegetables from farmers in the nearby areas, particularly perishable ones such as coriander, lettuce, yardlong beans, and water spinach. It is also similar to Fatemi and Asgarian's (2019) and Luis *et al.*'s studies (2010) which stated that the purchase of vegetables from farmers outside the areas which may require a long period of transportation can affect the cost of transportation and pose the risk of loss during transit. In addition, it is consistent with the need for vegetables to cook for patients at the hospitals; Naruok (2020) reported that 116 advance-level hospitals and standard-level hospitals under the responsibility of the Office of the Permanent Secretary, the Ministry of Public Health faced procurement problems, thus causing a delayed disbursement for farmers. Each hospital is urged to seek solutions to such problems.

Phase 4: Matching

The extension sector drew on the results from Phases 1 and 2 to reach negotiations that would benefit both the demand and supply sectors. This phase was implemented during the period of April – July 2021. It started with coordination which prompted each party to do some preparation and assign the authority or the representative to take part in negotiation sessions. Each was matched to have discussions and reach a fair agreement for all parties. There were four matchings, and that led to the emergence of four sub-platforms of DSMP (Figure 1) as detailed below.

1. DSMP between KPUVCE x Their farmer networks: It involves collaboration between the farmer networks in nearby areas and KPUVCE to produce GAP vegetables to the specified quantity and manage production risks.

2. DSMP between KPUVCE x ROI-H and PHO-H: It directly matches KPUVCE with two hospitals; purchase is made through e-bidding, and GAP vegetables are transported to hospitals directly.

3. DSMP between KPUVCE x Subcontract of Modern Trade (middleman): This is an indirect order matching platform between KPUVCE and modern trade via the subcontract of modern trade (middleman). Given that KPUVCE is short of working capital to manage increasing risks and financial liquidity is needed to cover certain expenses in accordance with modern trade's terms, it is not ready to sell vegetables to modern trade directly. KPUVCE reached an agreement with two subcontractors/middlemen, namely (a) an agreement between KPUVCE and KWKK Co. Ltd which acts as a middleman for LR-MT and (b) an

agreement between KPUVCE and KK Farm as a middleman for TM-MT and BR-MT.

4. DSMP between Extension sector x KPUVCE x Modern Trade x Hospital: The last platform entails promoting collaboration, passing on production knowledge and management of KPUVCE, providing budgets based on the needs of each area, and collaborating with modern trade and hospitals with the Roi Et Agricultural Extension Office as an organizer and a facilitator.

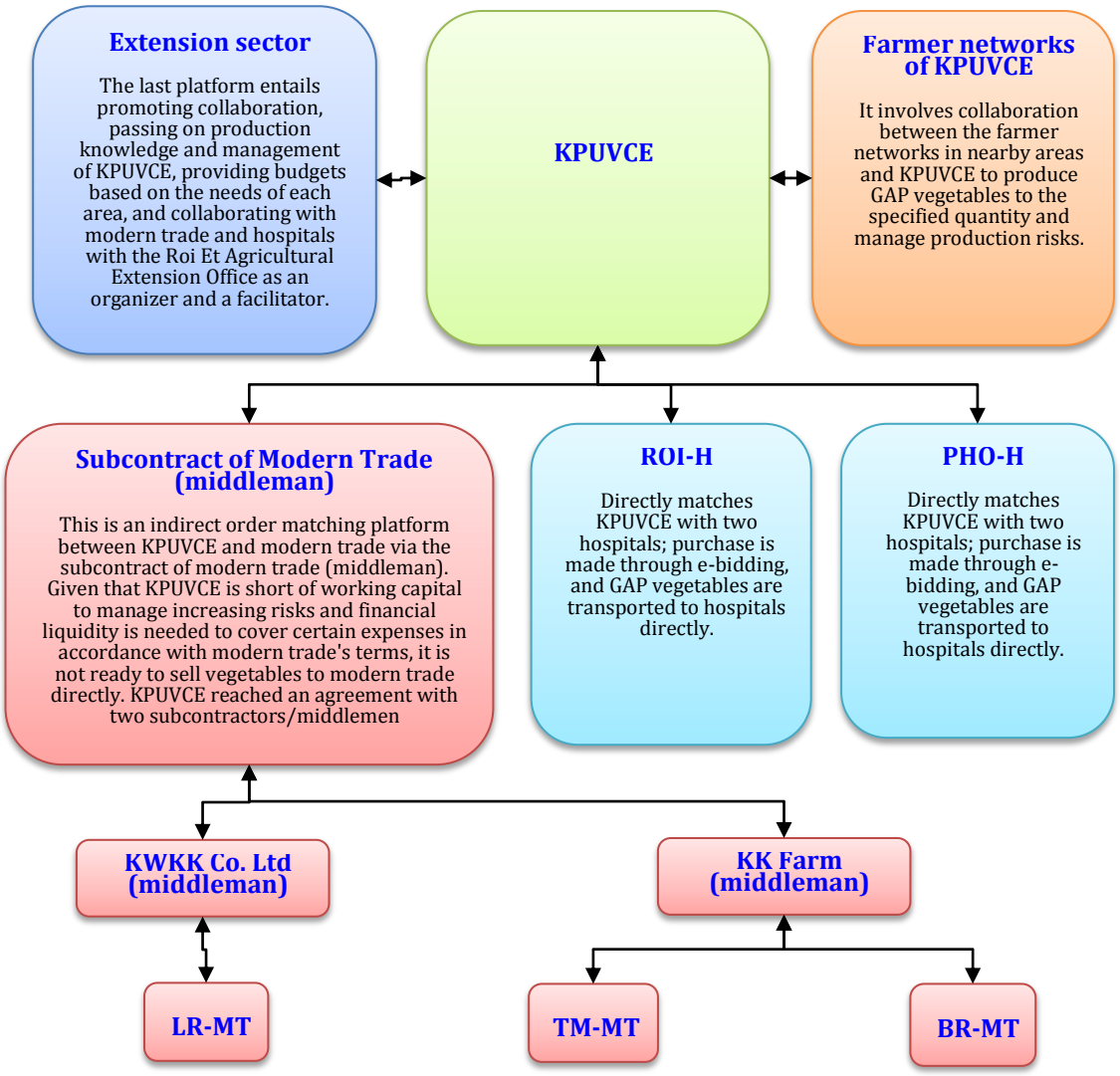

Figure 1 The general of demand-supply matching platform consists of 4 sub-platforms

It was found that all stakeholders agreed to each other's proposition, and that contributed to building a platform with fairness and balance between demand and supply. This finding corresponds to Dror *et al.*'s (2016) and Schut, *et al.*'s studies (2017) which mentioned that matching stakeholders to reach a mutual agreement via cooperation between public and private sectors would promote the demand-supply balance between producers and consumers.

Phase 5: Tools and services building

The extension sector drew on the results of three prior phases for tools and services building. The final phase was conducted during the period from July to October 2021. A commitment to procure tools and services was formed to allow for

fairness and balance between demand and supply. The tools and services of each sub-platform are different (Figure 2) as described below.

1. KPUVCE: It is the main sector that serves to produce vegetables, perform purchase negotiations, formulate cultivation plans, harvest crops, record information on the source of produce in a traceable record system, and transport GAP vegetables to the markets.

2. KPUVCE's farmer networks: It is KPUVCE's subsidiary which works in concert with KPUVCE to produce vegetables and formulate plans for the production of GAP vegetables.

3. Modern Trade: Modern Trade assigns the subcontract of modern trade (middleman) to provide KPUVCE and their farmer networks with suggestions on production, monitor production, purchase produce from KPUVCE and distribute products to modern trade. Specifically, (a) KWKK as a subcontractor of modern trade procures produce from farmers and distributes products to LR-MT while (b) KK Farm acts as a subcontractor of modern trade for TM-MT and BR-MT. Given that KPUVCE lacks the funds to manage the risks of due credit terms, there is a need for the subcontractor of modern trade to purchase KPUVCE's products with short credit terms. Tally Power of Simplicity (2021) mentions that credit terms are a term of payment agreed upon between purchasers and sellers concerning the due period and payment for goods purchased on credit, which allows purchasers to use or market products first and make the payment later. In the same fashion, as reported by Utaranakorn *et al.* (2019), the fact that the product promotion department of the company purchases vegetables and offers advice on production practices based on the company's preference will encourage farmers to participate in group activities.

4. Hospitals: As a business partner, purchases KPUVCE produce for hospitals directly. RoI-H and PHO-H hospitals were willing to decrease the period of credit term payment to no longer than 30 days; this short credit term can be managed by KPUVCE. This finding is akin to Narukon's study (2020) which reported that hospitals under the Office of the Permanent Secretary, the Ministry of Public Health attempted to develop a more effective financial system for the hospitals.

5. Extension sector: It serves to promote and develop agriculture as well as fund the construction of vegetable greenhouses and packing houses and develop production; it provided a budget of over 7.4 million THB. This is consistent with Ortiz-Gonzalo *et al.*'s study (2021) which reported that the use of agricultural innovations, such as plant breeding or planting control (greenhouse or closed production system), could help control the weather, diseases, and pests, thus reducing the loss of vegetable produce and allowing for the effective distribution of GAP vegetables to modern trade stores.

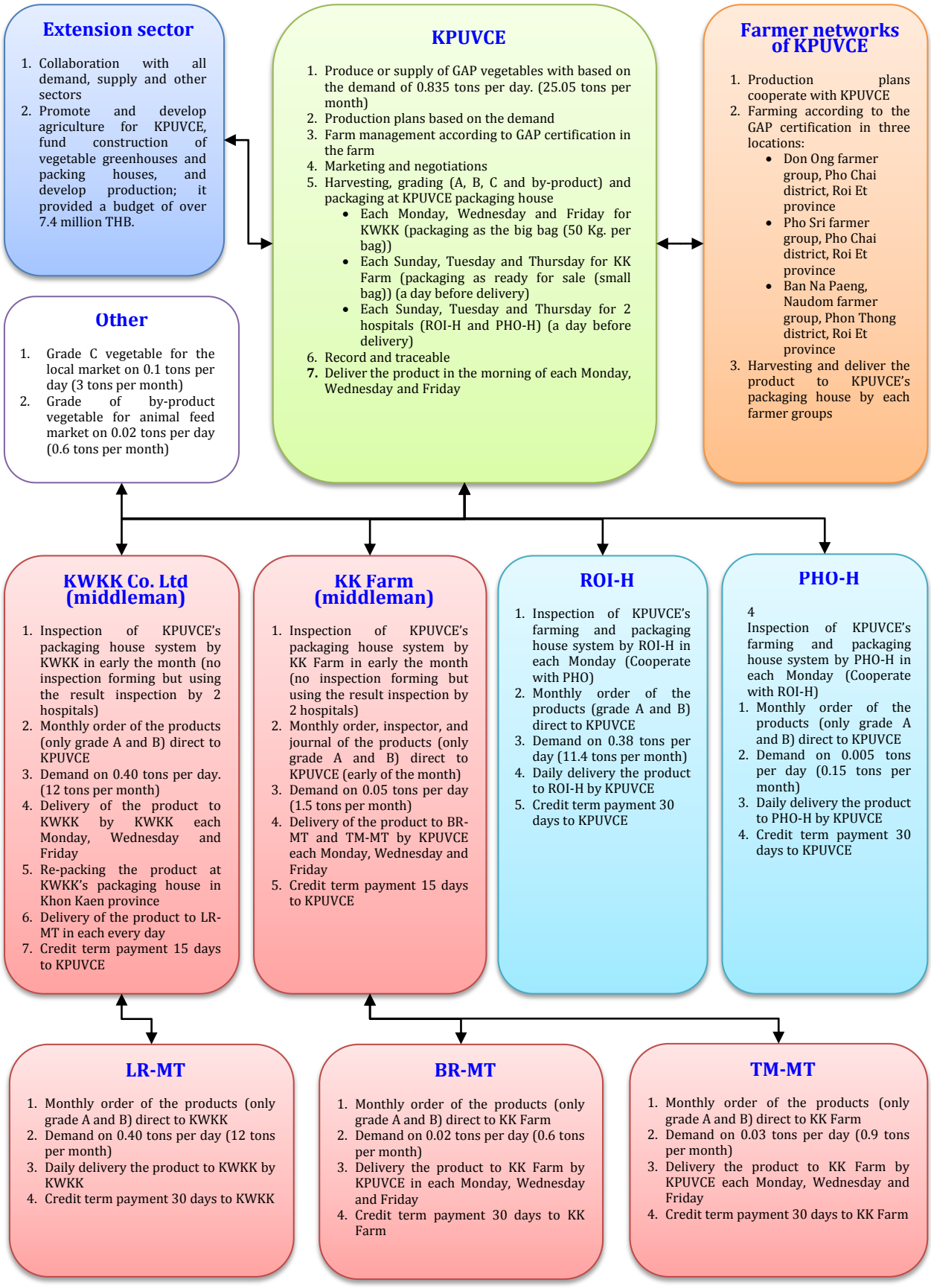

Figure 2 Tools and services building of demand-supply matching platform (DSMP) of GAP vegetables

Phase 6: Pilot Running and After-Action Review

1. Pilot Running

After the DSMP has been done were conducting a pilot running in the short term from October 2021 to September 2022, it was found that KPUVCE as a supplier could increase vegetables for the demand of modern trade and hospitals by 85% on average, and only 15% it is a challenge to DSMP balance (Table2).

2. After-Action Review (AAR) on Social Impacts or Changes Resulting from Development

With the development of the platform, the extension sector was conducting an after-action review (AAR) by organizing a brainstorming discussion to assess social impacts or changes as a short-term result of development on 21to 23 July 2021 Community Hall, Ban Kum Charoen, Kham Pha-ung sub-district, Pho Chai district, Roi Et Province, and data collection on vegetables by KPUVCE supplied to modern trade and hospital during October 2021 to September 2022. The development resulted in some social impacts or changes as presented below.

2.1 Supply sector: KPUVCE and their farmer networks were improved to enhance the effectiveness in the production of GAP vegetables. In particular, 16 vegetable greenhouses were built, along with the construction of packing houses to control the quality of production in compliance with the standards and the needs of the markets. The vegetable greenhouses not only helped increase the quantity of produce, despite climate change but also contributed to a 50% reduction in water usage and enriched soil with organic matter. However, vegetable production in greenhouses requires proper farm management according to academic principles.

2.2 Demand sector:

2.2.1 Hospital: Both hospitals as in ROI-H and PHO-H managed to solve procurement problems. As a result, the process of disbursement was accelerated, which allowed farmers to earn money faster, and the patients were provided with GAP vegetables that were safe, chemical-free, hygienic, and nutritious. The procurement of food in local areas from farms to hospitals and attempts to change the quantity of vegetable orders in accordance with the quantity of GAP vegetables produced by farmers in each season is a sustainable provision of food services to the patients. This is akin to Carino *et al.*'s study (2020) which mentioned that procuring food in local areas from farms to hospitals provided opportunities to establish relationships with communities and that changing purchase practices motivated farmers as business partners to procure food for hospitals.

2.2.2 Modern trade: All modern trade stores as in TM-MT, LR-MT and BR-MT purchased GAP vegetables from nearby areas, so they were supplied with fresh products. Purchasing vegetables from farmers outside the areas which may require a long period of transportation could increase the cost of transportation and pose the risk of loss during transportation. This goes hand in hand with Surucu-Balci and Tuna's study (2021) which reported that transportation was the primary cause of the loss of food; two logistics activities that most influenced the amount of the loss of food were sourcing raw materials and packaging of goods in transit.

Table 2. Pilot running of DSMP in the short term from October 2021 to September 2022

Date	Demand (Ton)												Supply (Ton)	The gap between all demand and supply (General and GAP vegetables)	The gap between the GAP vegetables demand requested and the supply from KPUVCE
	Modern trade						Hospital				All total demand (General and GAP vegetables)	Total of GAP vegetables demand requested from KPUVCE	KPUVCE (GAP vegetables)		
	TM-MT		LR-MT		BR-MT		ROI-H		PHO-H						
	All Demand (General and GAP vegetables)	GAP vegetables demand requested from KPUVCE	All Demand (General and GAP vegetables)	GAP vegetables demand requested from KPUVCE	All Demand (General and GAP vegetables)	GAP vegetables demand requested from KPUVCE	All Demand (General and GAP vegetables)	GAP vegetables demand requested from KPUVCE	All Demand (General and GAP vegetables)	GAP vegetables demand requested from KPUVCE					
Oct. 2021	69.05	17.263	47.01	7.052	40.5	6.075	37.77	18.885	0.16	0.16	194.49	49.44	49.44	**-74.58**	**0.00**
Nov. 2021	49.06	12.27	37.55	5.63	32.20	4.83	35.90	17.95	0.14	0.14	154.85	40.82	35.70	**-76.95**	**-12.54**
Dec. 2021	45.60	11.40	31.28	4.69	32.90	4.94	37.23	18.62	0.13	0.13	147.14	39.77	36.58	**-75.14**	**-8.03**
Jan. 2022	42.30	10.58	31.15	4.67	25.47	3.82	43.23	21.62	0.14	0.14	142.29	40.82	36.89	**-74.07**	**-9.64**
Feb. 2022	64.30	16.08	42.60	6.36	36.70	5.51	43.23	21.62	0.13	0.13	186.96	49.69	42.84	**-77.09**	**-13.78**
Mar. 2022	46.70	11.68	32.09	4.81	27.11	4.07	44.30	24.15	0.13	0.13	150.33	44.84	44.84	**-70.18**	**0.00**
Apr. 2022	48.20	12.05	34.28	5.14	29.53	4.43	42.40	21.20	0.11	0.11	154.52	42.93	28.20	**-81.75**	**-34.31**
May. 2022	52.10	13.03	39.20	5.88	33.71	5.06	37.87	18.94	0.12	0.12	163.00	43.02	31.62	**-80.60**	**-26.49**
Jun. 2022	49.75	12.44	34.30	5.15	30.45	4.57	49.37	24.69	0.12	0.12	163.99	46.96	30.60	**-81.34**	**-34.83**
Jul. 2022	48.20	12.05	36.07	5.41	31.20	4.68	49.50	24.75	0.25	0.25	165.22	47.14	38.75	**-76.55**	**-17.80**
Aug. 2022	51.45	12.86	38.48	5.77	33.11	4.97	40.00	20.00	0.25	0.25	163.29	43.85	38.75	**-76.27**	**-11.63**
Sep. 2022	45.25	11.31	36.36	5.45	31.04	4.66	49.57	24.88	0.20	0.20	162.42	46.50	46.50	**-76.99**	**0.00**
Total	**542.91**	**135.73**	**393.36**	**58.98**	**343.42**	**51.51**	**472.60**	**238.39**	**1.72**	**1.72**	**1754.01**	**486.33**	**411.26**	**-76.99**	**-15.37**

Conclusions

In relation to the question on what can be done to ensure the balance of demand and supply in the producer-consumer matching platform, it was uncovered that the supply sector taking part in the project was KPUVCE and their farmer networks while the demand sector included three modern trade stores as in LR-MT, TM-MT, and BR-MT as well as two hospitals including ROI-H and PHO-H. The developed platform comprised four sub-platforms. (1) DSMP between KPUVCE x Their farmer networks are a platform of collaboration for the supply sector and are responsible for producing GAP vegetables to the specified quantity. (2) DSMP between KPUVCE x Hospital is a direct order matching platform between KPUVCE and the hospitals as in ROI-H and PHO-H with a short credit term of 30 days. (3) DSMP between KPUVCE x Subcontractor of modern trade (middleman) is an indirect order matching platform between KPUVCE and modern trade via the subcontractor of modern trade which serves to pay cash or offer a short credit term to farmers to alleviate the limitation of a long credit term of modern trade paid to KPUVCE of which working capital is inadequate for management. (4) DSMP between Extension sector x KPUVCE x Modern trade x Hospital is a collaboration promotion platform between all sectors. The Roi Et Agricultural Extension Office served as an organizer and a facilitator and made a contribution of over 7.4 million THB to support the construction of an infrastructure for KPUVCE to drive DSMP. All in all, all stakeholders in these platforms accepted each other's propositions, and as a result, it led to the emergence of the platform with a demand-supply balance. To implement the platforms successfully, integrity and commitment from all stakeholders are required. Besides the benefits to farmers, consumers can consume GAP vegetables. As a result, it was found that KPUVCE could increase vegetables for modern trade and hospitals by 85% on average, and only 15% it is a challenge to DSMP balance.

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Author Contributions

Piyanat Setjant contributed as the project manager, facilitator and draft paper and Yos Borisutdhi contributed as the project mentor, facilitator and approved the final paper.

Conflicts of Interest

All authors declare no conflicts of interest.

Ethical statement

We declare that this manuscript is original, has not been published before, and is not currently being considered for publication elsewhere. We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome. Also, we further confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We confirm that any aspect of the work covered in this manuscript does not contain any studies with an experimental design using animals or humans as subjects performed by any of the authors. Lastly, we care for protect the pandemic of COVID-19 during project activity at the study site.

References

Aubry, C. & Manouchehri, N. (2019). Urban agriculture and health: Assessing risks and overseeing practices. The Journal of Field Actions Science Reports. 20, 108–111.

Bhaskaran, A.B., and Thaiyalnaki M. (2022). Consumer preferences on green marketing products in Chennai city. NeuroQuantology, 20(15): 3114-3120.

Borisutdhi, Y. (2015). Community Study: Perspective based on research and scientific process. Kaen University Printing House.

Carino, S., Porter, J., Malekpour, S. and Collins, J. 2020. Environmental sustainability of hospital food services across the food supply chain: A systematic review. Journal of the Academy of Nutrition and Dietetics, 120 (5): 825-873.

Chareonpanich, A. and Vongurai R. (2018). The factors affecting healthy lifestyle and attitude towards organic foods: A case study of people living in Bangkok, Thailand. ABAC ODI JOURNAL Vision. Action. Outcome, 5(1), 102. Retrieved from http://www.assumptionjournal.au.edu/index.php/odijournal/article/view/2958

Dhanashree, G.S. and Vetrivel, M. (2022). A Study on buying behavior toward green products in Tirunelveli city. NeuroQuantology, 20(15): 3121-3126.

Dror, I., Cadilhon, J.J., Schut, M., Misiko, M., and Maheshwari, S. (2016). Innovation platforms for agricultural development: Evaluating the mature innovation platforms Landscape. London, UK: Routledge.

FAO. (2020). Fruit and vegetables – your dietary essentials. The international year of fruits and vegetables, 2021, background paper. Rome. FAO.

FAO. (2022). Food and Agricultural Organization Statistical Database: Production. Rome. FAO.

Fatemi Ghomi, S.M.T., and Asgarian, B. (2019). Development of metaheuristics to solve a transportation inventory location routing problem considering lost sale for perishable goods. Journal of Modelling in Management, 14(24), 175-198.

Getprom, C., Kositpimanvach, E., Kongpet, Y., Pimthong, A. and Samrit Kangpheng, S. (2022). The strategy of driving the safe agriculture for food security of vocational education institute of agriculture under the Office of Vocational Education Commission. NeuroQuantology, 20(7): 1581-1589.

Kim, M.K., Jang, J.H., Potchanasin, P., Chae, W.B., Yoo, E.H., Taekryoun K. (2019). Current status and breeding perspectives of major vegetable crops in Thailand. Journal of the Korean Society of International Agriculture, 31(1), 67-75.

Kyriacou, M.C. and Rouphael, Y. (2017). Towards a new definition of quality for fresh fruits and vegetables. Scientia Horticulturae, (2018) 463-469.

Lamers, D., Schut, M., Klerkx, L., and van Asten, P. (2017). Compositional dynamics of multi-level innovation platforms in agricultural research for development. Science and Public Policy, 44(6), 739-752.

Luis, R.G., Pilar, B., Jose Ignacio, R., and Loredana, L. (2010). Testing ZigBee motes for monitoring refrigerated vegetable transportation under real conditions. Sensors, 10(5), 4968-4982.

Mahathanaset, I., and Pensupar, K., (2020). The impacts of cabbage importation on cabbage production in Thailand. Khon Kaen Agriculture Journal, 48(2), 381-394.

Moazed, A. and Johnson, N. L (2016). Modern monopolies: What it takes to dominate the 21st century economy. New York: St. Martin's Press.

Nachappa, A. and Sharma, D. (2022) A study on business marketing paradigms and tactics in the modern market. NeuroQuantology, 20 (16): 11-20.

Narukon, N., (2020). Food safety hospital service system of center hospital and general hospital under the Office of the Permanent Secretary, Ministry of Public Health. Journal of Public Health, 29(5), 884-896.

Ngatindriatun and Adzim, F. (2022). Agribusiness-based farmer empowerment model with a sustainable integrated farming system approach to increase income multiplier effect. ABAC Journal, 42(2), 267-292

Ofuoku, A. U. and Ogisi, O. D. (2020). Change management in vegetable farming: the case of farmers in Delta State, Nigeria. International Journal of Agricultural Technology, 16(6),1445- 1462

Ortiz-gonzalo, D., Ørtenblad, S. B., Larsen, M. N., Suebpongsang, P., & Bruun, T. B. (2021). Food loss and waste and the modernization of vegetable value chains in Thailand. Resources, Conservation and Recycling, 174: 105714. Retrieved from https://doi.org/10.1016/j.resconrec.2021.105714

Praditbatuga, P., Treetipbut, S. and Chantarak, S. (2022) The influence of service and food quality and perceived value on customer satisfaction of Thai Casual Dining Restaurants in The United Arab Emirates, ABAC Journal, 42(2), 51-96

Schut, M., Andersson, J.A., Dror, I., Kamanda, J., Sartas, M., Mur, R., et al. (2017). Guidelines for innovation platforms in agricultural research for development: Decision support for research, development, and funding agencies on how to design, budget and implement impactful Innovation Platforms. Kigali, Rwanda: International Institute of Tropical Agriculture (IITA), Wageningen University and Research Centre (WUR)

Sukhonthasing, P., (2519). Green market Phetchabun opportunities and strategies in Thailand 4.0. Phetchabunsarn Rajabhat Journal, 21(1), 1-16.

Supapunt, P., Intanu, P. and Chaikampun, K. (2021). Factors affecting farmers' adoption of good agricultural practice in vegetable production in the upper North of Thailand. International Journal of Agricultural Technology, 17(1), 349-362.

Surucu-Balci, E. and Tuna, O. (2021). Investigating logistics-related food loss drivers: A study on fresh fruit and vegetable supply chain. Journal of Cleaner Production, 318(2021), 128561.

Taguchi, M. & Santini, G. (2019). Urban agriculture in the global north and south: A perspective from FAO. The Journal of Field Actions Science Reports, 20(2019), 12–17.

Tally Power of Simplicity. (2021). Credit terms: Definition, type, example and tips. Tally Power of Simplicity. Retrieved from https://www.tallysolutions.com/accounting/credit-terms/

Thammajinda, R., Chingchayanurak, C., Jitaree,W., Trakarnsirinont, W., Navaratana na Ayudhya, T. (2017). The development of a sustainable community enterprise model: A case study of the Puk Plod San, Ban Don Satan Group in Pua District, Nan Province. Community Development Research Journal (Humanities and Social Sciences) 10(4), 98-107.

Thongkam, S., and Sasananan, M. (2014). Organic vegetable supply chain management: Case study of the food safety project in hospital. Interdisciplinary Research Journal: Graduate School, 3(2), 23-34.

Tisa, S., and Kumchai, J., (2022). Heterosis in chinese cabbage and selection of heat-tolerant varieties. Khon Kaen Agriculture Journal, 50(2), 330-339.

Utaranakorn, P., Mashino, K., and Yasunobu, K. (2019) Factors relates to member's contribution to group activities: A case of vegetable growing group at Baan Non Khawao in Khon Kean province. Journal of Economics and Management Strategy, 7(1), 81 - 93.

VanRooyen, A.F., Ramshaw, P., Moyo, M., Stirzaker, R., and Bjornlund, H. (2017). Theory and application of agricultural innovation platforms for improved irrigation scheme management in Southern Africa. International Journal of Water Resources Development, 33(5), 804-823.

WHO (2019). Increasing fruit and vegetable consumption to reduce the risk of non-communicable diseases. e-Library of Evidence for Nutrition Actions (eLENA). WHO.