AN AGROLINK ECONOMIC SYSTEM THROUGH AN INFORMATION TOOLBOX APPROACH

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ABSTRACT

Malaysia agricultural sector has been severely affected by the pandemic, as a result, the Agri-food supply chain has been disrupted since early 2020.The agri-food supply chain needs to be strengthened through a tighten collaboration between supply chain stakeholders in the sector. Data can be collected through technological solutions; market insights can be achieved through analysis and forecasting. The paper focuses on introducing an Agrolink economic system through an information toolbox approach. It is an aggregator of the information resources connecting all elements of the agri-food supply chain in Malaysia, which accessible by farmers, producers, service providers of the supply chain, agri-food associations, government agencies, and educational and research institutions. The information toolbox is deployed using Apache web server, MySQL database, and Laravel web framework. Information sharing through supply chain stake holders' connection. The information presented using data cataloging, information indexing, interconnection of information resources, and ranking in the information toolbox. Several events have been organized to guide how users could surf, search, find, and connect with what they hoped to achieve, assistance to create and discover the values of their companies and how they could identify their assets into the right places of the Agrolink system.

Keywords: Agricultural economic system, Information toolbox, Food supply chain, Agrolink

1.0 INTRODUCTION

Since March 2020, Malaysia agricultural sector has been affected by Movement Control Order (Prime Minister Office of Malaysia, 2020). Since then, local news has been reporting on these issues such as fresh vegetables being discarded due to supply chain issues, labor shortages leading to reduced productivity, inter-state movement restrictions disrupting transportation and deliveries, closure of non-essential business activities affecting market access, etc. The pandemic situation has severely impacted the supply of farmers to consumer demand activities. The occurrence of all these problems seems to point to an important issue, namely the lack of connectivity among stakeholders in the agricultural supply chain, or to be precise, the absence of a connected supply chain system in Malaysian agriculture.

The rise of the technology and the pandemic have driven a surge in digital transformation, and all sectors of the economy, including agriculture, have been forced to embrace the transformation and move into a new era of digital supply chain systems. A competitive, strongly connected supply chain enables the flow of information and the flow of economic trade. A competitive agricultural supply chain economic system can be achieved by leveraging technology and information, as well as the insights gained through supply chain connectivity. Malaysia's agricultural supply chain system can be strengthened to facilitate agricultural trade flows and empower agricultural business.

There is an urgent need for all stakeholders in the agricultural supply chain to implement technology solutions. Modern agricultural equipment and machinery is needed to replace many manual workers. And internet of things devices can be embedded in farms and production activities to manage, monitor, and collect data. E-commerce marketplaces needed to facilitate business activities, especially allowing small farmers to sell their products and reach customers. Market information can be retrieved through artificial intelligence analysis and forecasting, etc. The data created from technology solutions, automation, E-commerce marketplaces, and market insights can be shared among supply chain stakeholders to create value. Therefore, Malaysia's agri-food supply chain needs to be strengthened through close collaboration between supply chain stakeholders in the sector.

This paper presents an Agrolink system to connect agri-food supply chain stakeholders through an information sharing platform. The information toolbox was created to provide information and search for information on target crops for the agri-food industry in Malaysia. The Information Toolbox is an aggregator of information resources that connects all elements of the agri-food supply chain in Malaysia. It can be used by all farmers, service providers in the supply chain, associations, government agencies and educational institutions. This paper discusses the methodology and framework used in developing the information toolbox. The key findings of supply chain system, data catalog, indexing, interlinking information resources, page ranking, and information toolbox from the literature review below have been applied to the research methodology discussed in the paper.

2.0 LITERATURE REVIEW

According to Malaysia's Digital Economy Blueprint, agriculture is one of the preferred sectors for developing the digital economy. Government initiatives include promoting the adoption of smart agriculture by creating a centralized open data platform among industry players and creating more local digital platforms to enable "farm-to-table" digital marketplaces (Prime Minister's Department, 2021). Several books and academic articles have been reviewed to identify appropriate approaches and frameworks used to develop agroecosystems through information toolbox.

In The Global Supply Chain Ecosystems, the author describes the supply chain as the artery of today's globalized economy, enabling the flow of international trade and empowering global commerce. A complex international network of suppliers, stakeholders, partners, regulators, and customers are involved to ensure the efficient and effective flow of products, services, information, and funds around the world (Millar, 2015).

Through a study of a data catalog project, researchers developed a system that allows users to annotate their data products with structured metadata, providing a discoverable, browsable index of data for data consumers. A data catalog system can provide a roadmap of useful data obtained from experiments or simulations, making it easier for researchers to find and access important data, and understand the meaning of the data and how to obtain the data (Stillerman, Frediana, Greenwald, & Manduchi, 2016).

In the research paper titled 'Discovering, Indexing and Interlinking Information Resources', the authors discuss the crawling and analyzing web resources to populate a crawler database. The processes being implemented in the International System for Agricultural Science and Technology. It applied semantic enrichment to crawled web resources and used this semantic knowledge to enhance the web portal (Celli, Keizer, Jaques, Konstantopoulos, & Vudragović, 2015).

In a book titled 'Indexing It All', the authors describe the importance of indexing and the practical application of indexing in Google PageRank. As with Google PageRank, with its relevancy-based link-analysis algorithm, citation indexing and analysis is introduced into the corpus of what is searchable by the user, making the search more contemporary, rather than simply retrospective (Day, Buckland, Furner, & Krajewski, 2014).

In a book titled 'Google's PageRank and Beyond: The Science of Search Engine Rankings', the author suggested search engine results page techniques can be applied by mathematical algorithms with ranking components such as content score and popularity score in improving business and organization rankings in the major search engines (Langville & Meyer, 2012). In a research paper titled 'A Hessenberg-type algorithm for computing PageRank Problems', the authors' described PageRank is a widespread model for analyzing the relative relevance of nodes within large graphs arising in several applications and presented a Hessenberg-type algorithm for computing PageRank Problems (Gu, 2022).

In the research paper titled 'Neuroscience Information Toolbox: An Open Source Toolbox for EEG–fMRI Multimodal Fusion Analysis', a Neuroscience Information Toolbox (NIT) has been designed and developed to provide a convenient and easy-to-use toolbox for researchers for exploring brain information in various scalp electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) studies (Li Dong *w*, 2018).

3.0 RESEARCH METHODOLOGY

An Agrolink system is shown in Figure 1. It is designed as an information toolbox, a one-stop digital platform for agri-food marketing, e-commerce, and branding in Malaysia. By leveraging marketing and branding strategies, stakeholders from suppliers to buyers are connected to the online marketplace through a searchable information toolbox. Suppliers include large-scale agriculture, contract farmers, family farming and individual farmers. Commercial establishment refer to agricultural cooperatives, government agencies, business partners, companies, and corporations. Buyers refer to consumers, end-users, and foreign buyers. Online marketplaces refer to Malaysian-owned online stores and e-commerce platforms that specialize in agri-food online stores. The diagram shown a process flow which interconnected commercial establishment, supplier, and buyer towards online marketplaces. A branding report generated to help buyers and commercial stakeholders identify the proposition delivered by the organization's marketing and brand. A link to the web store is provided to access the organization's web store.

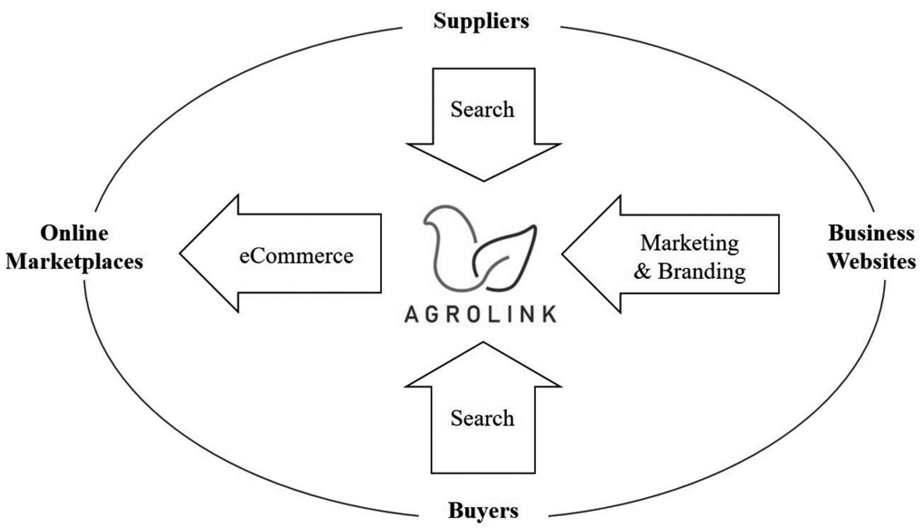

Figure 1: Agrolink economic system

The Information Toolbox (Table 1) consists of four main modules, namely, search, content, management, and forum. The search module uses techniques such as information indexing and cataloging to facilitate the storage and retrieval of information. The content module is used to manage content and resources, evaluate, and clean up. The administration module is used to support, maintain, and generate reports and statistics. Forum provides online discussions for dialogue and interaction. The programming tools including Hyper Text Markup Language, Cascading Style Sheets, Javascript, Bootstrap, Vue, Laravel, PHP: Hypertext Preprocessor, MySQL, and OAuth 2.0 are used to build the Agrolink web framework.

Table 1: The information toolbox structure consists of four main functional modules

No	Module	Sub-Modules
1	Search	Information indexing, Search Engine, Catalogue, Keyword, Label Tag, User behavior Indicator
2	Content	Content Provider, Content and Resource Management, Content Assessment, Content Cleansing
3	Management	Admin Management, Categories and Crops Management, Report and Statistic
4	Forum	Category, Post, Moderate

3.1 Information Indexing

The method of information indexing (Table 2) is described to allow users to access crop information in an organized and more structured manner. The information toolbox provides a platform for Malaysian agricultural stakeholders to freely share and contribute their knowledge and valuable information on a collaborative information toolbox platform. All contributed information is well indexed to facilitate users to search and access targeted information without searching the entire database.

The process of information indexing involves tagging information with specific tags and keywords. Information indexing tags have been identified and discussed with agricultural stakeholders. Any popular crops not listed in the information toolbox can be suggested through a feedback form.

Table 2: The method of information indexing consists of label tagging used in the index

No	Information Indexing	Labels Tagging
1	Agricultural sub-sectors	Crops, Fisheries, Livestock
2	Crops	Ginger, Star Fruit, Herb, Cucumber, Lady Finger, Broccoli, Cauliflower, Cabbage, Corn, Beans, Root, Vegetables, Melons, Chili, Eggplant, Jack Fruit, Durian, Pomelo, Pineapple, Leafy Greens, Salad, Greens, Mushroom, Coconut.
3	Fisheries	Wild Catch (Fish), Wild Catch (Crustaceans), Wild Catch (Mollusks), Aquaculture (Marine), Aquaculture (Fresh Water), Aquaculture (Crustaceans)
4	Livestock	Poultry (Broiler), Poultry (Layers)
5	Supply chains	Refer Table 3

3.2 Information Organization

The method of cataloging (Table 3) is used to organize agricultural information by creating metadata to represent information resources. The catalog divides the agri-food supply chain into five different sectors, namely production, harvesting and transportation, processing and storage, distribution, packaging and handling, and wholesale and retail (Malaysia Productivity Corporation, 2018). For each supply chain sector, more specific subsectors have been identified and categorized to enable users to locate and select the most appropriate resources. The directory provides information describing the contributors, titles, and keywords of the listed resources. This information refers to a wide range of information resources that can be accessed through the Uniform Resource Identifier. Due to the limited number of pages allowed, the level of detail is not listed.

Table 3: The method of cataloging is used to categorize the agri-food supply chain into five different sectors

No	Cataloging	Information Organization
1	Agricultural sub-sectors	Crops, Fisheries, Livestock
2	Supply Chains	Production, Harvesting and Transport, Processing and Storage, Distribution, Packaging and Handling, Wholesale and Retail
3	Crops	Refer 3.1 - 3.5
3.1	Production	About the Crop, How to Plant, Pest and Disease, Advice, Statistics, Financial Aid, Technology, Agro-Tourism, Certification, Crop Scouting, Weed Management, Organic Cultivation, Product
3.2	Postharvest	Harvest, After harvest, Transportation, Financial Aid, Technology, Product, Agro-Tourism
3.3	Processing	Uses, Financial Aid, Technology, Product, Agro-Tourism
3.4	Distribution	Financial Aid, Import and Export, Technology, Product, Market Place
3.5	Retail	Uses, Statistics, Financial Aid, Import & Export, Technology, Product, Market Place
4	Fisheries	Refer 4.1 - 4.4
4.1	Production	Fry, Farm Table Sizes, Feed Millers, Quality Control, Veterinary, Financial Aid, Technology, Certification, Product
4.2	Processing	Financial Aid, Technology, Certification, Transportation, Value Addition, Storage Facilities, Product
4.3	Distribution	Financial Aid, Technology, Uses, Statistics, Import and Export, Product
4.4	Retail	Technology, Market Place, Product
5	Livestock	Refer 5.1 - 5.4
5.1	Production	Farms, Breeds, Health and Disease, Technology, Advice @ Rules and Regulation, Product

5.2	Processing	Technology, Transportation, Certification, Packaging, Storage Facilities, Financial Aid, Product, Value Addition
5.3	Distribution	Technology, Financial Aid, Uses, Statistics, Import and Export, Product
5.4	Retail	Technology, Restaurant, Product, Market Place

3.3 Generic Website Flow of Pages

A generic site flow (Table 4) is used to guide users' access to information in a simple structure. Linear style hyperlinks provide a direct path from beginning to end, making it easy for users to follow and retrieve the resources they need. The landing page is the primary entry point for identifying user groups such as farmers, businesses, institutions, government, and the public. The secondary page shows the three main categories of the agri-food sector, namely crops, fisheries and live stocks. One of these categories can be selected by users to access the third level web page. On the third level web page, a specific sector, namely production, postharvest, processing, distribution, and retail can be selected by users. On the fourth level web page, a detail level of subsectors which is related to the selected supply chain can be selected by users to access a list of information resources.

Table 4: A generic site flow used to guide users access to information in a simple structure

No	Website Flow	Description
1	The landing page	Farmer, Supplier, Government, Institutions, Public
2	Secondary page	Crops, Fisheries, Livestock
3	Third level page	Production, Postharvest, Processing, Distribution, Retail, and the subsectors of the supply chains
4	Fourth level page	Detail level of subsectors, and a list of information resources

3.4 Ranking

The ranking criteria (Table 5) are applied, and the coding instructions for ranking calculations are developed in the information toolbox. Listing resources will be ranked using the scoring criteria and a finite sequence of coding instructions to achieve fair visibility and avoid manipulation of rankings. A standard rating scale from 1 to 5 is implemented on the star rating card as a valuable metric to fairly collect user perceptions of a listed resource. A population standard deviation formula is used to maximize accuracy as data are collected in real time and entered the algorithm instantaneously. 25 percent dispersion percentage is acceptable, which is equivalent to 0.675 standard deviations. The popularity of the listed resource is reflected by the number of viewers through user clicks. To avoid manipulation, the viewer variation must be 0.80, which means that 80 percent of the viewers must come from different viewer sites. All criteria such as total views, average rating, percentage deviation and viewer variation are combined with the rating points, resulting in rating points from high to low.

Table 5: Ranking criteria used to achieve fair visibility and avoid manipulation of rankings

No	Criteria	Details
1	Rating	From not relevant (1) to excellence (5)
2	Minimum average rating	3.50
3	Rating percentage deviation	25%
4	Minimum viewers	10
5	Viewer variation	0.80
6	Rating point	Total viewers x average rating x [1/percentage deviation] x viewer variation
7	Ranking	Rating point from high to low

3.5 Forum and Web Framework

The modules and structure of the forum (Table 6) was established to allow stakeholders to interact and initiate dialogue on agricultural topics. It provides a platform to connect Malaysian agricultural stakeholders and build an online agricultural community. An administrator acted as a moderator to moderate the discussions, maintain the quality of the forum, and keep it free from spam and irrelevant topics. The content of the forum can be viewed by visitors or guests. Registered members are allowed to post on the forum, make comments, and start new discussion topics. A file may be attached to a post, but the file size is limited.

Table 6: Modules and structure of the forum used to build an online agricultural community forum

No	Item	Details
1	Categories	General, Crops, Fisheries, Livestock, Feedback
2	Roles	Moderator, Member, Guest
3	Structure	Tree-like Three levels - Categories, Topics, Posts A Thread starting by a title, the collection of posts is displayed from the latest to the oldest
4	Posts	Member can submit messages, which consist of texts, images, and HTML tags. First post creates a thread starter, the thread can contain any number of posts.
5	Rules	Anonymous can view all topics and messages, only register member can post messages.

During the soft launched in year 2020, Agrolink information toolbox has been deployed in Tunku Abdul Rahman University College's Integrated Innovation Hub. During deployment, it also used Huawei cloud computing compute service. Laravel web application framework used to develop the Agrolink information toolbox. It is built according to the model-view-controller architectural pattern, separating the data model and business rules from the user interface. Apache software is installed as web server, MySQL is installed as a database server, and PHP Hypertext Preprocessor is used as the primary programming language. Hyper Text Markup Language, Cascading Style Sheets, Javascript, Bootstrap, and Vue are used to build the front-end user interface. The framework architecture is divided into three layers, namely, client, application, and database. OAuth 2.0 is used to provide application programming interfaces authentication. It is used to enable an external system and a chatbot built by another institution to exchange data and functionality with Agrolink information toolbox.

4.0 RESULTS AND DISCUSSION

As shown in Figure 2, the opening page of the information toolbox has been designed to identify five different user groups, namely farmers, suppliers, government, institutions, and the public. All key players or stakeholders in this complex agricultural supply chain, from farmers to end customers, are identified, with each stakeholder playing a key indicator of this information toolbox. The user groups were decided to place at the opening page, after several rounds of discussions and meetings with relevant ministry agriculture agencies, consultants, sector players, and development team members. From time to time, suggestions can be taken to be discussed in the next phase improvement and development. When stakeholders are willing to share their valuable data resources and communicate with each other through digital platforms, a connected supply chain community can be created to build a sustainable Malaysian agricultural ecosystem that helps each other in production, processes, logistics, branding, and marketing.

Figure 2: The opening page of the information toolbox

As shown in Figure 3, there are three main categories in the agri-food sector, namely crops, fisheries and livestock, which have been incorporated into the information toolbox. The crops and items under these categories are listed as indicators to guide the user to the next supply chain page. Items and products not found under the categories, but are considered as common and major commercial, agricultural products can be suggested to be added by admin through a feedback form.

Figure 3: Three main categories in the agri-food sector

As shown in Figure 4, there are five different sectors, namely production, harvesting and transportation, processing and storage, distribution, packaging and handling, and wholesale and retail. For each supply chain sector, more specific subsectors have been identified and categorized to enable users to find and select the most appropriate resources.

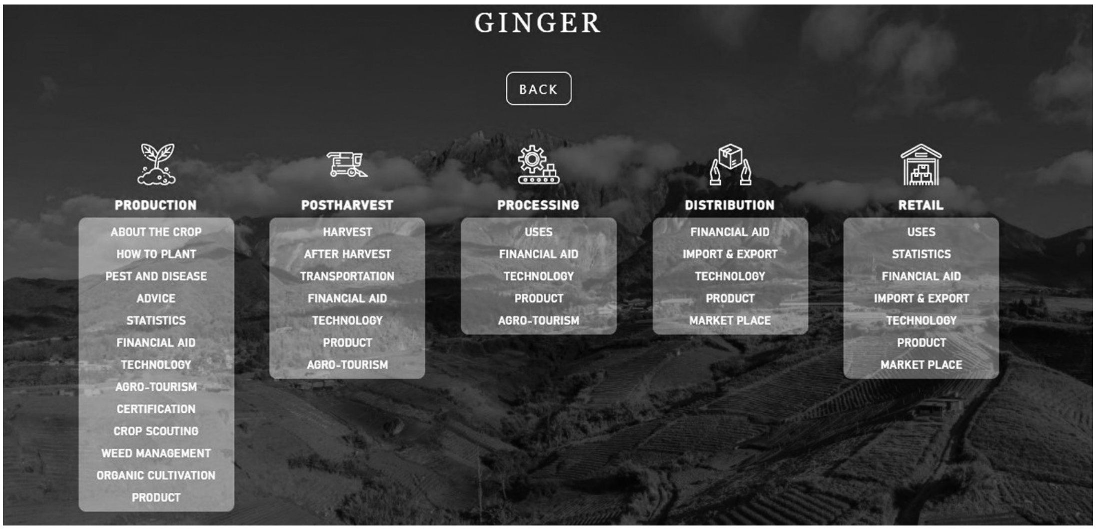

Figure 4: Five different agri-food supply chain sectors

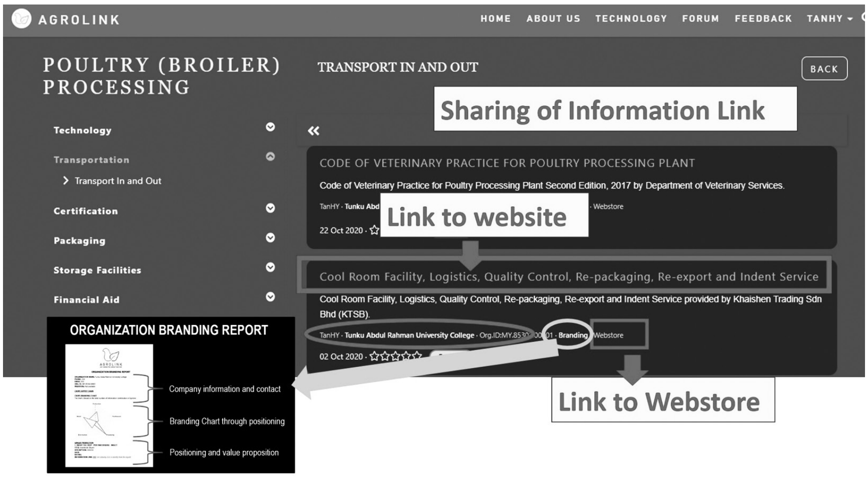

Figure 5: The resources shared by stakeholders

As shown in Figure 5, the resources shared by stakeholders include a wide range of information that can be accessed through the Uniform Resource Identifier. Contributors are listed by name and organization and a link is provided to enable access to the organization's website. An organization's brand report is generated that identifies the organization's brand positioning through a supply chain positioning chart, and the positioning and value proposition are listed in the report. The brand report helps consumers and stakeholders identify the benefits and unique selling proposition delivered by the organization's brand. A link to the web store is provided to access the organization's web store.

As shown in Figure 6, a supply chain positioning chart is generated for crops as. The chart is based on the total number of information contributions in the current information toolbox and have the potential to be expanded. The overall view of the Dynamic Supply Chain Competitive Forces Model can be outlined by the five supply chain elements, production, post-harvest, processing, distribution, and retail. It is drawn on organizational supply chain positioning to determine competitive strength. A valuable supply chain value insights can be gained from the supply chain positioning chart to inform organizational decision makers in shaping organizational brand strategy and industry competitive development.

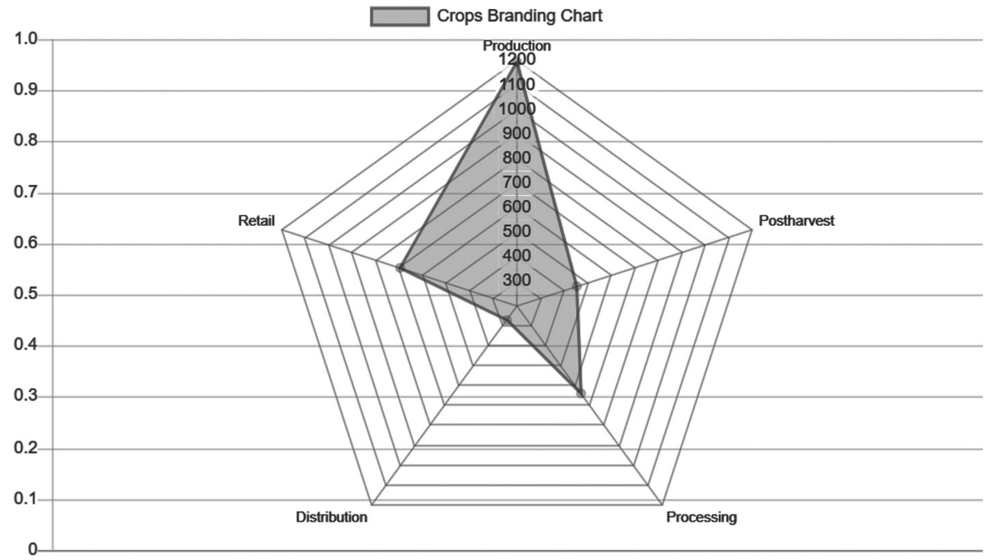

Figure 6: The supply chain positioning charts

Figure 7 presents the user response and registration statistics through registration and user data collected from the Agrolink portal in January 2021. The figure shows the relative proportions of the five user groups, with institutions at 47%, the public at 39%, farmers at 9%, vendors at 4%, and government at 1%. The Registered Organizations categorized into government agencies, industry, and higher education institutions. Number of links contributed to the three sub-sectors and to each supply chain. There were 3284 resources contributed to the crop subsector, 460 to the fisheries subsector, and 291 to the livestock subsector.

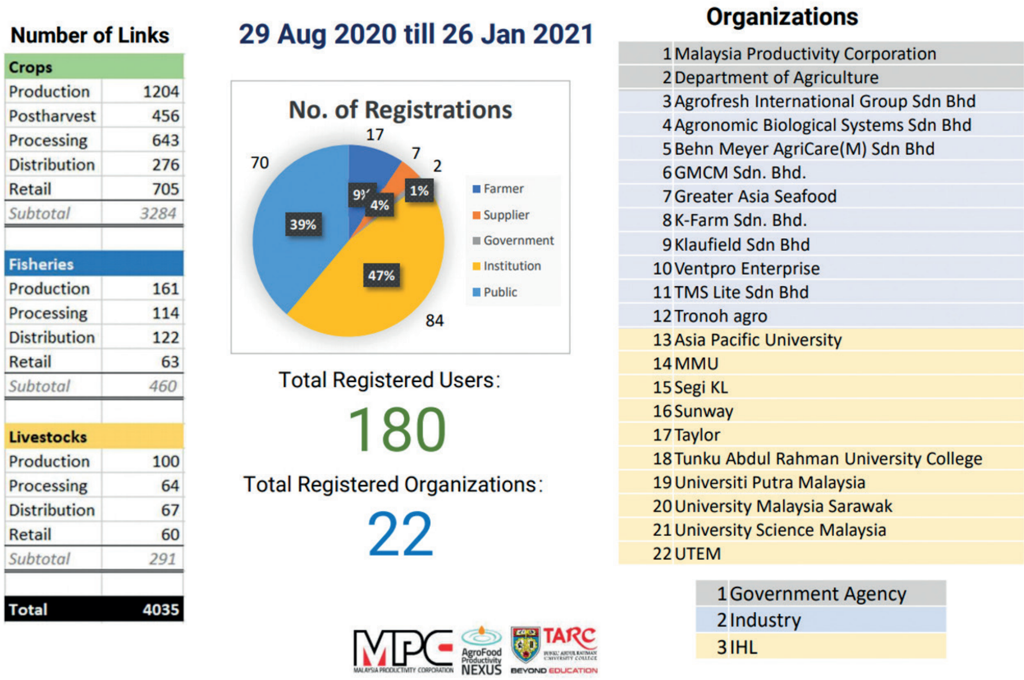

Figure 7: The user response and registration statistics

5.0 CONCLUSION

The Agrolink system aligned with the initiatives of the National Digital Blueprint by creating the Information Toolbox, a collaborative digital that connects supply chain stakeholders and shares information platform. The system is designed to fill the gap of no having any digital agricultural information toolbox to connect supply chain stakeholders in Malaysia. There are some famous shopping platforms in Malaysia such as Shopee and Lazada which are owned by Shopee Pte. Ltd. and Alibaba Group. Data sovereignty belongs to foreign companies, and Malaysian users will never use the data assets generated by the portal for business competition, operations, and productivity.

Agrolink system is deployed using Apache web server, MySQL database, and Laravel web framework. Information sharing through supply chain stake holders' connection. The information presented using data cataloging, information indexing, interconnection of information resources, and ranking in a digital information toolbox platform. A branding report generated to help buyers and commercial stakeholders identify the proposition delivered by the organization's marketing and brand. Collaboration and participation can be increased through online communication forum. OAuth 2.0 is used to provide application programming interfaces, authentication and authorization accessing an external system and application accessing resources in Agrolink information toolbox. In the initial phase, information is collected through manual input from stakeholders. Automatic connections can be deployed in the information toolbox through application programming interfaces to replace the manual approach when stakeholders digitized their operations.

Several promotion programs have been organized via online webinar. The events, dive deeper into the functions of the Agrolink information toolbox, guided how users could surf, search, find, and connect with what they hoped to achieve, assistance to create and discover the values of their companies and how they could identify their assets into the right places of the Agrolink. As a result of the promotion events, the overall response in terms of resource contribution and registration is satisfactory. However, a long-term plan and more aggressive extension efforts needed to bring in more agricultural players to build a strong and sustainable agricultural linkage among the agri-food sector in Malaysia. ■

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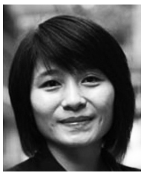

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