Jurnal Ilmiah Teknik Elektro Komputer dan Informatika (JITEKI)
Vol. 8, No. 3, September 2022, pp. 388-398
ISSN: 2338-3070, DOI: 10.26555/jiteki.v8i3.23650

Capsicum Apps: Creating Innovation Space of Chili Supply Chain through the Triple Helix Model in Central Java Indonesia

Suko Irawan [1], Sri Astuti [2], Nanda Mei Istiqomah [3], Ernoiz Antriyandarti [4]
[1,3] Study Program of Soil Science, Faculty of Agriculture, Universitas Sebelas Maret, Jl. Ir. Sutami No.36 A, Kentingan, Jebres, Surakarta 57126, Indonesia
[2,4] Study Program of Agribusiness, Faculty of Agriculture, Universitas Sebelas Maret, Jl. Ir. Sutami No.36 A, Kentingan, Jebres, Surakarta 57126, Indonesia

ARTICLE INFO

Article history:

Received March 22, 2022
Revised July 09, 2022
Accepted August 22, 2022

Keywords:

Triple helix concept;
Capsicum Apps;
Chili supply chain;
Industrial 4.0;
Education;

ABSTRACT

Chili is one of the essential commodities in Indonesia, and every region has different conditions in the vegetable trading system. The difference is caused by the additional amount of marketing agencies and supply chain management roles. Chili production that fluctuates annually causes an unstable selling price that affects chili farmers' welfare. This paper discusses applying the triple helix model to the interaction between universities, business entities, and Government to create innovation space through Capsicumm Apps. This study used a qualitative approach to seeking the truth by discovering the essence of the Value Chain Center. The Causal Loop diagram, as a part of the system thinking approach, was used as the analysis tool. The result from the discussion shows that multi-stakeholder interaction opens the opportunity for a small farmer to get involved in chili supply. Furthermore, institutional innovation can reduce cultivation risk, provide financial support, and ensure agro-input availability for increased production.

Corresponding Author:

Ernoiz Antriyandarti, Universitas Sebelas Maret, Jl. Ir. Sutami No.36 A, Kentingan, Jebres, Surakarta 57126, Indonesia
Email: ernoiz_a@staff.uns.ac.id

1. INTRODUCTION

Indonesia is an agricultural nation where agriculture produces food and horticultural crops. Food and horticultural crops are the most significant business activity spread throughout Indonesia. Horticultural crops have vegetables, fruits, ornamental plants, and medicinal. Chilli is a horticultural crop widely planted in Indonesia, one of them grown in Java. Chilli is one of the essential commodities in Indonesia, which has influenced inflation since 2010. Chili production from 1990-2015 is the biggest in Java (57.21%). Chili production has contributed to several provinces from 2011-2015 East Java (31.03%), dominated by cayenne pepper, West Java (14.89%), dominated by red chili; and Central Java (13.41%), balanced between cayenne pepper and red chili. Total national chili consumption is projected to reach 482.925 tons in 2016, an increase of 1.275 compared to the year 2015, and is expected in 2017 to increase by 1:23% of the projected figure in 2016, 488.872.

Every region has different conditions in the vegetable trading system, especially chili. The difference is caused by the additional amount of marketing agencies and supply chain management roles. Central Java is the province that has the longest chain of red chili distribution. Chili production that fluctuates annually causes the unstable selling price of chili commodities, affecting chili farmers' welfare described by one of the ability indicators levels/farmers' purchasing power in rural areas, namely, Farmer Exchange Rates (NTP). NTP is a comparable index of prices received by farmers (It) toward the index of fees paid by farmers (Ib). NTP also shows agricultural products' exchange power (term of trade) with goods and services consumed and production costs. Higher NTP means a relatively more substantial farmers' purchasing power ability level/purchasing power. OT (Output Transfer) and NPCO (Nominal Protection Coefficient Output) are also the welfare indicators of chili farmers. OT (Output Transfer) value in Java is negative, proving that farmers

receive a lower chili price than they should. NPCO value indicates that red chili farmers do not get product price protection. FT negative showed that farmers pay the non-tradeable inputs lower than they should. As for traceable inputs, farmers spend more than they should. Input protection traded is 106%. Due to NT being negative and EPC being less than 1, it can be concluded that red chili farming has not received adequate protection. It is very influential on local farmers' welfare.

Chili is an essential commodity for finance. Change the price of chili, which has influenced inflation. Chili prices condition is often unstable due to the distribution chain system that is too long and the lack of innovation and profitable chili cultivation information. It could be explained that the price equilibrium exists when the supply of chili is lower than its demand. This will cause the price to be very high.

On the contrary, if the supply of chili is more significant than its demand, the price will be low. Because of the disproportion of supply volume and consumer needs frequently occurring on vegetables, the price fluctuation of chili is higher than other secondary crops. A significant change in the price of chili does not provide beneficial circumstances for vegetable agribusiness. It harms the decision for investment as a result of uncertainty in return. The fluctuation in price often makes a higher loss for farmers than traders/collectors because farmers cannot manage sales to obtain a better price. Price fluctuation also triggers asymmetric market information, resulting in a high marketing margin; traders take advantage of this situation as they can provide misleading price information to the farmers. The price received by the farmers and price transmission from the consumer's area to the producer's region is low.

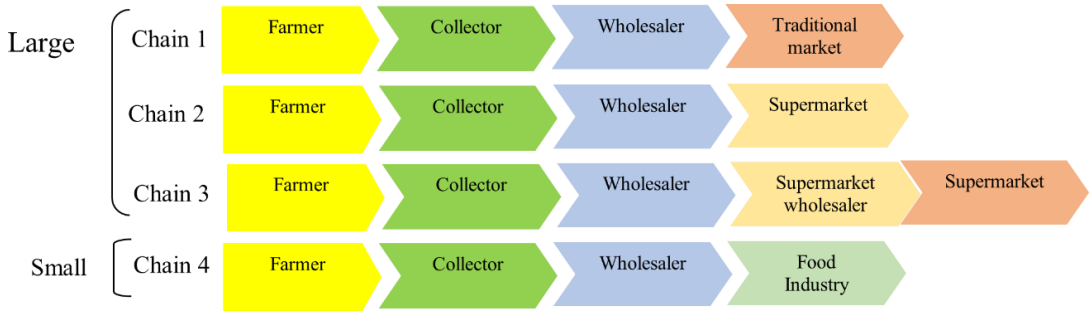

Fig. 1. Distribution chain system of small and large chili farmers [1]

On the other hand, lack of information about disease control, pests and techniques cultivation, and innovations received by chili farmers often cause crop failure. Whereas suppose the data can be accessed. In that case, farmers can increase the production of chili or minimally can withstand severe disease, pests, and extreme weather conditions [2], [3]. Furthermore, the Agribusiness of Chili is profitable both the private social and the activities of Chili agribusiness cause no disadvantage. Thus, agribusiness of chili can be further developed. The non-tradeable inputs of chili farming have been used efficiently and provide added value for farmers. The demand for chili is more profitable, supplied by domestic production rather than imports.

However, farmers receive chili prices lower than they should and do not get product price protection. Farmers pay the non-tradeable input lower than they should. As for the tradeable inputs, farmers pay higher than they should. It can be concluded small farmers in developing countries generally have some bounds in accessing the technologies, extension services, and market integration. This condition also happened to fruit and vegetables small farmers in Indonesia. Thus, they cannot meet the export standard requirements such as continuity of quantity, quality, food safety, and competitive prices. To enhance the competitiveness of Indonesian fruits and vegetable commodities in the global market, comprehensive development of supply chain management is required. A supply chain management can create and distribute the value added to all involved actors in this agribusiness. Supply chain management integrates the primary business process from the end-user through the distributors, which spreads the services and information that has value-added for the consumers and other stakeholders [4], [5].

Entering the industrial revolution 4.0 era opens vast opportunities for anyone to develop, so we must be able to adjust ourselves to market demand. The difference between the Industry 4.0 revolution, which will bring many changes from production relations to social relations, from cultural structures to political movements, is the fact that it is promising to evolve into a collaborative design by triggering the developments in technology one after another, and that it is being expected to show its effects in every field of scientific progress [6]–[9]. Agriculture will follow other industrial sectors, and the benefits of digital technologies will materialize and become a source of increased production efficiencies once ubiquitously available data are effectively employed. In a global economic environment, a nation’s agricultural

competitiveness and ability to sustain critical natural resources will be strongly tied to its ability to innovate in these aspects of the production system [10]–[13]. Realizing the need for digital transformation, economic entities of the agricultural sector are trying to intensify the processes of informatization of their activities while maintaining the existing business model, which allows them to increase productivity and quality of management significantly but does not provide the conditions for the formation of a digital platform adequate to the requirements of the digital economy [14]–[16]. The evolution of agriculture steps into Agriculture 4.0, thanks to the employment of current technologies like the Internet of Things, Big Data, Artificial Intelligence, Cloud Computing, Remote Sensing, etc. The applications of these technologies can significantly improve agricultural activities' efficiency [17]–[19].

Information technology can be accessed all over the country and can connect everyone in a digital world service, supported by facts from the digital market research institute. Internet facilities that are easy to access make the whole Community of all ages and professions to use it. People can access all kinds of content offered by various sites and social media. E-marketer stated that in 2018, the number of active smartphone users in Indonesia was more than 100 million. Digitalization in agriculture is thus expected to provide technical optimization of agricultural production systems, value chains, and food systems [20], [21].

Furthermore, it has been argued that it may help address societal concerns around farming, including the provenance and traceability of food [22], animal welfare in livestock industries [23], and the environmental impact of different farming practices [24]. Based on the problem above, the author has the idea to provide educational information services and online marketing services to the Community to further develop chili cultivation in Indonesia by making the idea of Capsicum Apps integrated with the triple helix concept as an innovation to avoid misuse of technology and information. Capsicum Apps is a digitalization agriculture expected to enhance knowledge exchange and learning, using ubiquitous data and improve monitoring of crises and controversies in agricultural chains and sectors. Parallel with the emergence of the knowledge-based economy, research into national innovation systems has flourished over the past 50 years. Indeed, national and regional innovation scholars have dedicated considerable effort and attention to understanding how and when linkages between governments, economic actors, universities, and other institutions may identify opportunities for innovation that deliver value to all stakeholders [25]–[27].

This research discusses a case study of the "triple helix model" applied interaction between universities, business entities, and government to create an "innovation space" for chili supply chain management. In our view, triple helix can be applied with Capsicum Apps for considerably optimizing chili farming and supply chain distribution, form present as a digital-based service application as an information and education source, and logistics to support increased productivity and chili marketing. This research provides empirical insights into the role of the triple helix model and how to change information in the industrial 4.0 era to optimize chili's cultivation and supply chain through Capsicum Apps.

2. METHOD

This study used a qualitative approach to observe the utilization of information technology to develop a chili supply chain by involving the government, academicians, businessmen, and chili farmers. In the participant observation approach, the researcher is directly involved as an active agent and source of information, actively participating in the learning process now or being a passive recipient of data, as well as melting together researchers in the research process as an insider and outsider simultaneously. This study applied a Causal Loop diagram to comprehensively discuss the role of the Triple Helix Model, developed by the Value Chain Center (VCC), in developing fruit and vegetable supply chain management, which involves small farmers in fulfilling the global market demands. System thinking is a part of system dynamics. This approach used the information feedback perspective and delays to determine the complexity of biology, physics, and social system.

3. RESULTS AND DISCUSSION

Industry 4.0 and digital technology have been shortcuts in alleviating conventional marketing and cultivation management problems. Business models have influenced consumer preferences in choosing products [28]–[31]. Furthermore, in the context of new technological innovation, the most challenging task is how to build an excellent digital ecosystem framework. Given the lack of empirical research emphasizing 'practice' as the site for the emergence of a hybrid triple helix innovation model, an exploratory qualitative research approach was meaningful and appropriate to advance insight into the organizing practices of the three institutional spheres of the triple helix. In this regard, qualitative data collection methods were adopted to help us capture the triple helix protagonist has lived experiences and inherited knowledge, which was of prime importance in generating relevant insights into their everyday organizing practice.

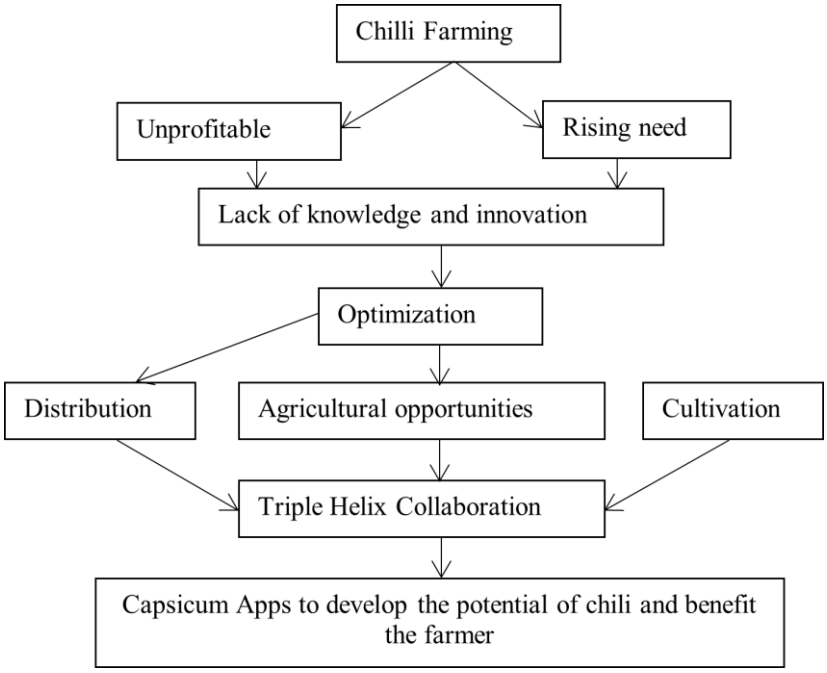

Fig. 2. The framework of Capsicum Apps

Value-added creation is an effort to embody business efficiency, while value-added distribution is a process to create business equity [32]–[34]. Efficiency and equity are the requirements to actualize competitiveness due to the characteristic of Indonesian fruits and vegetable farmers, which mostly have small-scale businesses and are scattered in different production areas. A previous study from [35] shows that creating an innovation space between universities, business entities, and government can significantly impact vegetables and fruit value-added, and collaborative cooperation with farmers as a central point is crucial. The small farmers were encouraged to apply the collective system in their business by strengthening the farmer's group. On the other hand, the university must act as the "best quality engineer producer" from best quality engineer vegetables and fruit can meet market standard demand. There is a need to connect Good Agricultural Practices (GAP) and Good Handling Practices (GHP) to solve various problems that occur due to minor farmer hindrances. The government can set a rule for the Community in terms of the economic relationship, specific to determining the usage of resources, distributing profit, and reducing risk and transactional costs due to the hindrances of the involved actors.

The following picture is related to the framework of thinking to overcome the problem of the chili supply chain. The Triple Helix model is a network-based approach that targets social relationships and collaboration among sectors to facilitate knowledge exchange and interactive learning [36]–[38]. According to [39]–[42], the triple helix presents a solution to developing creativity, innovation, and technology. Human resources intellectuals are needed to drive creativity, innovation, and technology in this modern era. In addition to adequate human resources, seizing opportunities requires that the institutional and higher education frameworks adapt to the new context by adopting and assimilating technologies for creative use, thus leading companies to internationally competitive products and services. The evolutionary triple helix model has developed with various concepts and its implementation. The triple helix model has three main dimensions: geography refers to the government, which has the power to rule the area. Knowledge refers to academicians who create and share innovation within the site, and economics refers to business entities that make economic activities within the region. Explained that the interaction between the dimensions would create Knowledge infrastructure, Political Economy and Innovation, which is said to be the competitive advantage for the area. Also, the capacity for such partnerships to stimulate innovation and generate inclusive economies has attracted much research. The evolutionary triple helix model advocates strategic interactions and collaboration between universities, industry, and government [43], [44]. The concept of a knowledge hub has been used by several countries as part of their strategies to utilize knowledge to build competitive advantages in the knowledge-based economy.

Capsicum Apps is an idea that discusses the development of chili supply chain management by basing the triple helix model as a means to develop strategies and create innovations to increase productivity, build

new markets, and ensure adequate agro-input for a small farmer. Fig. 3 shows the triple helix model in the chili supply chain that involves small farmers.

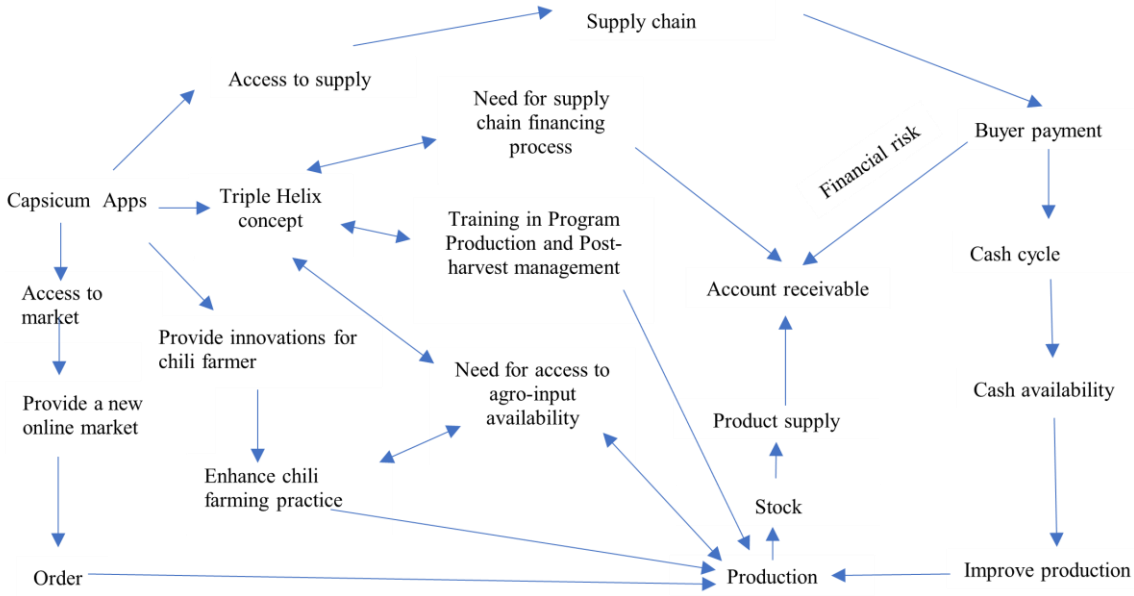

Fig. 3. The triple helix model in the developing chili supply chain involves small farmers.

The triple helix model is the facilitator in improving the small farmers' market access to the export market. The small Indonesian farmers generally sold their products to the traditional market (wet market) through the local collectors. Indonesian development in 2025, where society is an essential element in addition to the government sector, business sector, and academic or university sector as an embodiment of product, determining the direction of policy and keeping a robust business environment. In these causal loops, the discussion role of the triple helix can start from everywhere. However, in this study, the discussion started from market access because the causal loop started to develop chili supply chain management by establishing the market by linking with part of the triple helix to increase small farmer welfare. Therefore, the triple helix role between academicians, government, and business people can be the best collaboration as a problem solution in society. Capsicum Apps are linked with a new market for small farmers. Inclusively, Fig. 3 shows the role of the triple helix model as the facilitator in improving the small farmers' welfare through unique online market access that can establish chili supply chain management and provide price protection. Because In general, the small Indonesian farmers sold their products to the traditional market (wet market) through the local collectors. Besides, they do not have a bargaining position, making small farmers get a lower price than they should.

Capsicum apps are the application model to create innovation space and facilitate improving the small farmers' market access and get farmer welfare. In general, small Indonesian farmers sell their products to the traditional market (wet market) through local collectors at a minimum price because farmers do not have access to selling directly to the market. On the other hand, increasing chili production when the market is not fit can negatively impact traditional market behavior. Innovation space is needed in the conventional market, which is a chance to create a new online market to face the demand. With a new online market, farmers can sell directly. Unique market access can increase demand for chili, which in turn can guarantee price stability and become an incentive for farmers to increase chili production. Capsicum Apps also play a role in stabilizing the supply chain so that they can find buyers more quickly through more straightforward payment methods that can accelerate economic transactions, which means farmers do not have to wait long to sell products, thus resulting in a more stable cash flow.

As an innovation space, the Capsicum application serves as a source of innovation to increase the added value of chili. This increase can be done through proper cultivation management and post-harvest processing. Then the government, as part of the triple helix, acts as a reducer of the risk of crop failure by providing services to improve the capacity of smallholders so that they can access high-quality agro-input technology. The availability of agro-inputs is a vital aspect, and to increase chili yields, chemical fertilizers, pesticides, and quality seeds play an important role in increasing crop productivity; furthermore, the use of organic

fertilizers enriched with biological agents is a preventive measure in control of disease-causing pathogens that often attack horticultural plants in the vegetative growth phase [24]. Extension related to chili cultivation, post-harvest processing, product diversification, and encouragement of access to business capital requires the role of the government that is responsive and sensitive to the problems experienced by small farmers.

Strengthen linkages between universities with local interests (chili supply chain), placing the university as not an ivory tower, no longer solely or supplement. University becomes a key component in the process. As essential instrumentation, universities play a positive role in bridging the public interest for developing the business sphere, economic growth, community empowerment, and local initiatives; this interaction will generate positive feedback, grow behavior, and strengthen the chili supply chain in small farmers. Based on the discussion above, it is clear that the triple helix model in creating innovation space for the chili supply chain is very complex. Still, this model can be understood as a thinking approach, not a way of thinking, because it will require linearity and a rigid mindset. Flexibility and simplification of many aspects to achieving the desired goal.

Capsicum Apps is a mobile application with the triple helix concept dedicated to chili farmers. It comes as a solution to chili farming and the supply chain border. Capsicum Apps' home page displays general information consisting of references, updated news uploaded by academicians, and direct links from various media sources. Constraints faced by chili farmers can be delivered through the SYI (Share Your Information) feature, automatically connected with academicians and the government in the group chat feature. The academicians consist of lecturers and students who concentrate on developing chili farming. References Published in informative news are packaged in an easily understood language. The login feature to the mobile application Capsicum Apps has three categories: academicians, businessmen, and government. The author divides Capsicum Apps development focus into two primary functions: an educational and online trading center with goods traded specifically for chili farming logistics needs, which can consist of seeds, organic fertilizer, germs, and others.

Fig. 4. Capsicum Apps application displays

Capsicum Apps on mobile applications has five essential features: Home, Order, Assistance, Inbox, and Accounts. Fig. 5 presents an explanation of these five basic features.

Capsicum Apps is an information service and distribution product for chili farming. Serves as a question-and-answer media with competent parties. Moreover, the product distribution and product order guaranteed no fraud. Capsicum Apps mobile application utilized as an educational information media and purchase of products/ services has several advantages, including the Community (chili farmers) to get valid and accurate information about the chili farming business.

Capsicum Apps' homepage features are Order, Help, SYI, and Account

Home Page 	Initial display after successfully logging in. Contains the most popular and updated information related to the chili world. Capsicum Apps Admin has the role of filtering/ selecting news so that the report does not contain hoaxes.
Order 	The order feature contains information on ordering chili farming logistics; like an online store (Bukalapak, Shopee), there will be information about the total price, delivery time, and shipping service as additional information for consumers. The order feature for business people contains a list of orders for further processing. The order feature includes rating information on the number of items business people sell, so consumers are not deceived.
Help 	It contains information about application procedures for using Capsicum Apps when there are constraints in the features offered. The help feature has a call center that Capsicum Apps users can contact anytime.
SYI (Sharing Your Information) 	It is a forum for users to ask questions and provide input and critique to reference uploaded producers and founders of Capsicum Apps. Furthermore, this feature can also be developed into a forum discussion. This feature is built **to** create an integration of each party belonging to the triple helix so that through discussions in SYI, new ideas or ideas will be solved, problem-solving together, or sharing of knowledge and technology, the impact can be created on a solid cultivation base through triple helix integration.
Account 	Contains account user self-information.

The Capsicum App has four main features: Reference, Chili Mall, Settings, and About Us. Following is an explanation of the four main features:

Reference 	Feature Reference contains general knowledge and research results researched and published by academicians. Research information about product innovation is expected to apply to the Community (farmers) in their farming.
Chili Mall 	The Chili Mall feature contains information on logistics chili products (product innovation or service from lecturers, students/ entrepreneurs) offered through Capsicum Apps. Entrepreneur verification is carried out through several steps to guarantee that the entrepreneur's account is authentic. Chili Mall will be integrated into the basic features of 'order.' Buyers can reconsider their decision after knowing the track record of the seller/businessmen so that potential buyers are deceived can be minimized.
Setting 	The settings feature will contain information about the regulation regarding Capsicum Apps that application users can set, such as languages and others.
About Us 	About Us, the feature will contain general information about the Capsicum Apps mobile application.

Fig. 5. Capsicum Apps features

Academicians can submit their ideas and product innovation research into this mobile application so that the student's creativity to develop chili farming will be increasingly advanced, assisted by sophisticated technology. Government support is also needed concerning regulations to support chili farming distribution and protection for producers and consumers. In Capsicum Apps, there are three optional login methods: academician, businessman, and government, as illustrated in Fig. 6.

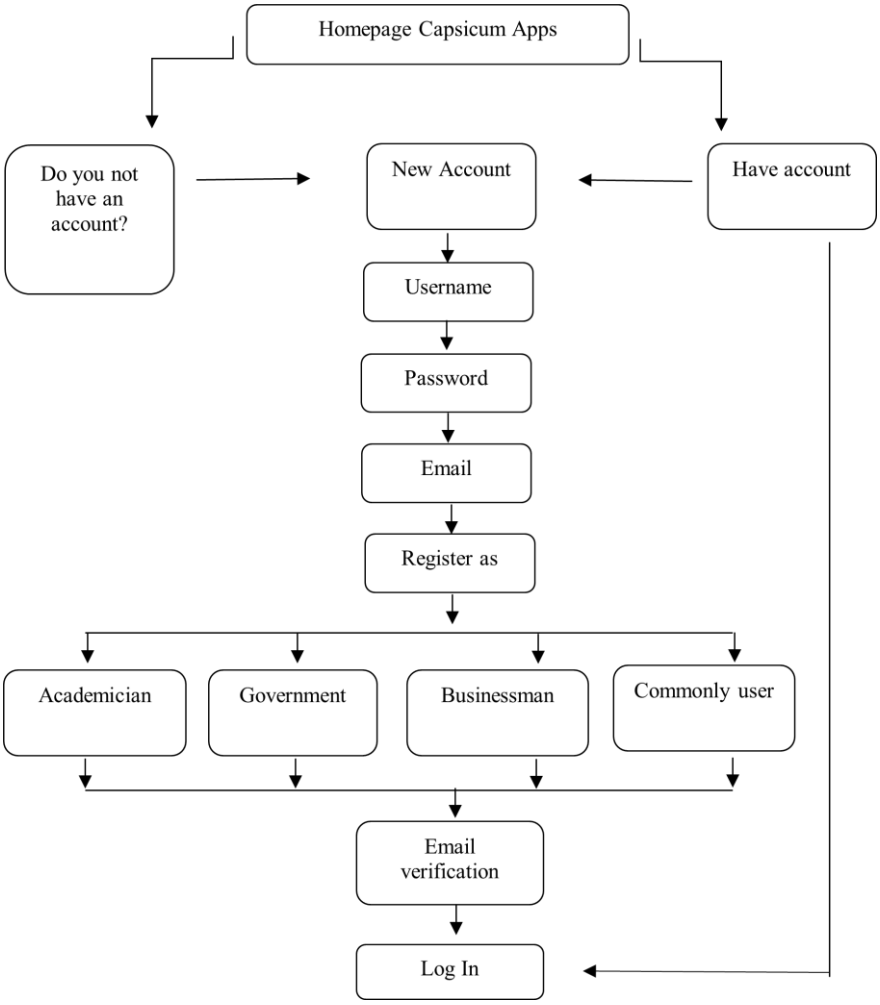

Fig. 6. Capsicum Apps log in step by step

[45]–[48] explained that the stakeholders collaborate to frame the supportive policies in this model based on Ministry Roles in Making Indonesia 4.0. This mobile application is expected to be supported by universities to become an agent providing information about the world of chili farming. The Community feels the benefits of chili farming development. The triple helix is crucial to the Community (farmers) for the continuation Capsicum Apps program. Table 1 describes the respective roles in the triple helix collaboration Capsicum Apps in mobile applications related to the Community (farmers).

Table 1. Role of Triple Helix for the Community (Chili Farmers) on Capsicum Apps Application Mobile.

No.	Parties Involved	Role
1.	Academicians	a. Giving them information about the chili cultivation technique. b. Delivering innovative opinions or ideas in the form of research results so that they can be applied to the chili cultivation technique.
2.	Businessmen	a. Providing the goods, the Community (chili farmers) need in chili farming. b. Selling the chili cultivation yields. c. Giving information about the overview of their agricultural business sector.
3.	Government	a. Getting input to determine the policy direction. b. Through Capsicum, mobile apps can monitor and control the chili price of chili farming products to protect producers and consumers. c. Determining the capital policy of chili farming.
4.	Community (Farmers)	a As an information recipient about chili potential and cultivation. b As an executor of the information application obtained from chili cultivation information. c As a consumer of chili sellers.

Capsicum Apps comes in the form of an application that focuses on one topic: chili farming, with keywords that are easy to remember and search, making it easier for smartphone users to find this application. Capsicum Apps are designed using an inconspicuous color tone and intended to reduce feature utilization, which is less efficient because too much utilization of features can make a connection to the application heavier, so visitors are lazy to wait for the loading. Capsicum Apps also conducts online promotions supported by other tools, such as social media. This function will make these applications more interactive and enhance the appeal, so the follower is motivated to use the Capsicum Apps application.

4. CONCLUSION

The multi-interaction between universities, business entities, and government can involve the small farmers in creating innovation space for increasing supply chain management, set of relationships rule the production level, and potential agricultural risk due to improper management. Furthermore, Capsicum Apps is a mobile application that can be utilized to overcome the problem of the development potential of chili farming by utilizing the Internet as an information system technology in the era of industrial revolution 4.0. The available features aim to educate the Community (farmers). Developing these economic corridors aims to optimize agglomeration advantages, explore regional strengths, and reduce the spatial imbalance of economic development throughout the country. For further research, it is necessary to develop the Capsicum Apps and its implementation strategy so that all actors in the chili value chain can be involved so that the purpose of utilizing this triple helix-based application can be achieved.

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