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**FACTORS DRIVING THE SYSTEMATIC GROWTH OF
ORNAMENTAL FISH EXPORTS: WITH SPECIAL REFERENCE TO
NORTH WESTERN PROVINCE, SRI LANKA**

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ABSTRACT

Production and export of ornamental fish is a lucrative market opportunity. It has earned valuable foreign exchanges during the past years. This study was conducted to identify the factors that have led to the systematic growth of ornamental fish export in North Western Province, Sri Lanka. North Western Province was selected for this study due to its favorable climate and suitable space for ornamental fish farming. Primary data was collected from all thirteen exporters engaged in the export of ornamental fish in the Kurunegala and Puttalam Districts of the North-Western Province by using a self-administered questionnaire. The collected data were analyzed through Statistical Package for Social Sciences (SPSS) version 29. KMO and Bartlett's Test, Reliability Test, and Descriptive Statistics were used to analyze the data. Four hypotheses were developed to measure the relationship between the variables and examined using Pearson Correlation Analysis and Multiple Regression Analysis. The results of this study revealed that the factors of ornamental aquaculture technology, knowledge and skill development, production cost, and awareness of the market were positively correlated to the systematic growth of ornamental fish exports. Subsequently, ornamental aquaculture technology, knowledge, and skill development were found to significantly affect the systematic growth of ornamental fish exports, while production cost and awareness of the market were found to be insignificant. Overall, this study found that the independent variables of ornamental aquaculture technology, knowledge, and skill development affect the systematic growth of ornamental fish exports in the North Western Province of Sri Lanka. This study recommended that by identifying the factors behind the growth in the export of ornamental fish, strategies, incentives, and programs should be put in place for its improvement.

Keywords: Awareness of the Market, Knowledge and Skill Development, Ornamental Aquaculture Technology, Production Cost

1. Introduction

The evolution of the ornamental fish industry serves as a captivating way that reflects a combination of human culture, technological development, and environment friendliness. Historical information shows that people have shown love for keeping ornamental fish since ancient times (Sinha et al., 2016). It was not until the nineteenth century that aquarium technology, transportation, and colonial exploration and trade began to take shape. With the advent of steamships and the expansion of railways, it became possible to transport ornamental fish from one corner of the world to another. The twentieth century can be considered a year of significant transformation in the ornamental fish industry, making the growth of commercial breeding operations and the spread of specialized aquaculture techniques.

The export of ornamental fish contributes a substantial earn in multibillion dollars. Throughout the historical periods, the industry has sustained an impressive average growth of approximately fourteen percent per year (Rani et al., 2014). According to the latest trade information on ornamental fish on the OEC website, between 2021 and 2022, ornamental fish exports decreased by 13.1% from \$390M to \$339M due to the Covid-19 pandemic and the top exporters of ornamental fish in 2022 were Indonesia - \$44.6M, Singapore - \$38.2M, Japan - \$37.6M, Netherlands - \$25.8M, and Sri Lanka - \$23.3M.

The ornamental fish industry in Sri Lanka was first an area of unrecognized export potential in the 1930s when fish enthusiasts used to import their favorite fish varieties. Sri Lanka exports mainly Guppy. Besides Molly, Glow Tetra, Fighters, Catfishes, Gouramis, Plates, Goldfish, and Angel can be mentioned. The export market for Sri Lankan ornamental fish is the USA, Japan, the UK, Germany, France, etc. (EDB, 2024).

1.1. Problem Statement

Ornamental fish farming and export are mostly done in the Colombo District in Sri Lanka (Weerasinghe & Malkanthi, 2022). Sri Lanka is a tropical climate country (Meteo, 2024). As a result, the parts of the country are well suited for the aquarium sector (Perera, 2009). North Western Province was selected for this study, due to its favorable climate, and space in lands suitable for ornamental fish farming (Perera, 2009). Therefore, compared to other regions of Sri Lanka, there is interest in ornamental fish farming among entrepreneurs in the North Western Province (NAQDA, 2016), but their performance is lacking due to some obstacles (EDB, 2024). It is important to note that, although many people in this province doing ornamental fish farming, very few

people export them directly (Heenatigala, 2007).

1.2. Research Objectives

This research is expected to achieve the following objectives:

1. To identify the effect of ornamental aquaculture technology on the systematic growth of ornamental fish exports in North Western Province, Sri Lanka.
2. To identify the effect of knowledge & skill development on the systematic growth of ornamental fish exports in North Western Province, Sri Lanka.
3. To identify the effect of production cost on the systematic growth of ornamental fish exports in North Western Province, Sri Lanka.
4. To identify the effect of awareness of the market on the systematic growth of ornamental fish exports in North Western Province, Sri Lanka.

2. Literature Review

The ornamental fish industry forms an essential part of international trade, an aesthetic delight, and a financial opening in the state-of-the-art expansion. This industry is one of the fastest-growing sectors in the world. Most of the ornamental fish available on the global market are sourced from developing countries in tropical and subtropical regions (Shankar et al., 2019). According to Rani et al. (2013), the systematic growth of ornamental fish exports is characterized by planned strategies, coordinated efforts, and continuous improvement across the various sectors of production, marketing, and distribution, and the organized development of international trade in ornamental fish species. On the other hand, FAO (2019) has stated that the export of ornamental fish is mainly for recreational and decorative purposes and involves systematic processes of breeding, familiarization, and transportation, including freshwater and marine species. It is analyzed by Tarihoran et al. (2023) export competitiveness and identified the barriers to ornamental fish exports in Indonesia. Also, many researchers have researched the relationship between export competitiveness and the development of economic integration (Mayes, 1978; Balassa, 1965). Competitiveness can be defined as, “a frequently used approach in economics for understanding a country’s trade performance, and it may be examined at three different levels: national (i.e., macroeconomic), industry (i.e., branch), and business (i.e., microeconomic)” (Bojnec & Ferto, 2014). The concepts that affect export competitiveness described by Tharihoran et al. (2023) include export financing resources, supply chain, market knowledge/export marketing, corporate reputation, promotion endeavors, evaluation of export market growth, personal contact with international distributors, and proximity to the global

market.

Rani et al. (2013) have identified that India shows positive systematic growth as it ranks fifth in the world, in terms of growth rate in export value of ornamental fishes, ranks fourth in terms of growth rate recorded by the quantity of ornamental fishes exported, and ranks eighth in terms of growth rate recorded by unit value of ornamental fishes exported. Meanwhile, Heenatigala (2007) in this study has been able to identify some of the main factors that currently limit the production, expansion, and development of the ornamental fish industry in Sri Lanka. Among the factors identified by this study were high production costs, inadequate knowledge skills and support, and problems with marketing. Moreover, this study has recommended that to overcome these problems, remain competitive, and maintain systematic growth in the global market, the industry should first apply science and modern technology. Strong research and development activities are required, covering breeding and development of new varieties, improving nutrition and feeding, disease control, and farm management. While that study brings such results, another study stated that the annual growth rate of ornamental fish exports from Sri Lanka shows fluctuations of various magnitudes over the years (Herath & Wijewardene, 2014). According to this, the lowest annual growth rate was shown in 2001, and the maximum value was recorded in the year 2003. Fluctuation in ornamental fish export values fell from the peak and in the year 2007 again showed a decline in the export growth rate. The annual growth rate of the compound indicates that there was a significantly lower growth rate. According to their findings, the industry has shown a positive growth rate since 2005, but it has a declining trend. The same pattern was obtained by Jayalal and Ramachandran.

Sekharan et al. (2007), have identified the factors that hamper the ornamental fish production sector in Tamilnadu including electricity charges, financial difficulties, terminal strains, infrastructure, market information, demand, marketing problems, space constraints and technical advice, etc. It is revealed that the above factors positively affected the study. In addition, the factors identified by Heenatigala (2007) include production cost, knowledge and skill and support, and, marketing issues, and these factors have also been a positive affection towards fish production in Sri Lanka.

In this study, ornamental aquaculture technology is one of the factors affecting the growth of ornamental fish export. In one of the studies written in this regard, it has been mentioned about the technology affecting the development of ornamental fish aquaculture in South Africa and some of the main concepts have been described (Kaiser et al., 1997). The concepts such as stocking density, water exchange rate, nutrition, color enhancement of ornamental fish as well as filial cannibalism.

Knowledge and skill development are very important to the ornamental fish industry. It is fundamental to the growth and sustainability of the industry. An in-depth understanding of fish biology and techniques for their practical implementation in ornamental fish farming is essential to maintain healthy fish populations and meet market demand. A study of competitiveness and barriers to the export of ornamental fish in Indonesia by Tarihoran et al. (2023) mentioned the concept of export knowledge. Export knowledge refers to the knowledge and experience gained by an organization when exporting its products to the market (Negeri & Ji, 2023). An exporter must know about regulatory certifications and documents affecting a company as well as information about the export of the final product.

According to De & Ramachandran (2011), the growth of the ornamental fish sector involves several cost factors. Meanwhile, initial set-up costs such as obtaining suitable facilities, tanks, filtration, and equipment are related to this. Apart from this, the cost of purchasing breeding stock, quality feed for fish, suitable labor forces, and transportation of fish play a significant role.

Awareness of the market of the ornamental fish industry means a comprehensive understanding of the various local and global factors influencing the buying and selling of ornamental fish, including new market trends, consumer preferences, regulatory requirements, and competition (Tarihoran et al., 2023). Studies written on the ornamental fish industry have often focused on understanding consumer behavior, market dynamics, and the regulatory framework. According to Tarihoran et al. (2023), many studies have been conducted on Dynamic Capabilities (DC), but some studies have mentioned less about micro-enterprises.

On the whole, it should be noted that the literature written on the systematic growth of fish exports is very limited.

3. Methodology

3.1. Data Sources

3.1.1. Conceptual Framework

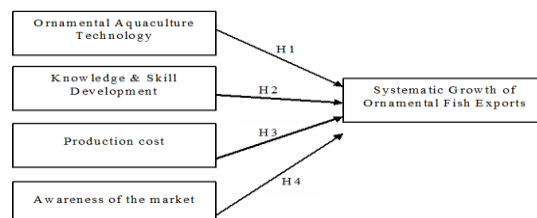


Figure 1: Conceptual Framework.

Ornamental Aquaculture Technology

Ornamental aquaculture technology can be defined as the specialized techniques and equipment used to breed, raise, and maintain ornamental fish species such as tropical fish, coral reefs, and other marine and freshwater organisms (Nurlaili et al., 2021).

Knowledge and Skill Development

Knowledge and skills are a fundamental component that significantly affects the competence of individuals in a particular field or industry (Echtelt, 2020). Information obtained through sensory applications such as reading, watching, listening, and touching can be defined as knowledge, and skill can be defined by the ability to effectively apply this knowledge in specific situations, and the improvement of both of these is called the knowledge and skills development (Murray, 2017).

Production Cost

Production cost refers to the total cost incurred by the business to produce a specific product from labor, raw materials, or consumable supplies and is equal to the costs incurred to obtain the capital, labor, materials, and other process cost factors involved in the production process (Kafi & Taseen, 2022).

Awareness of the Market

Awareness of the ornamental fish industry can be taken from several factors, including new trends, consumer preferences, regulatory requirements, and competition (Tarihoran et al., 2023).

Systematic Growth of Ornamental Fish Exports

The systematic growth of ornamental fish exports is characterized by planned strategies, coordinated efforts, and continuous improvement across the various sectors of production, marketing, and distribution, and the organized development of international trade in ornamental fish species (Rani et al., 2013).

3.1.2. Research Hypotheses

H1: Ornamental aquaculture technology has a positive impact on the systematic growth of ornamental fish exports in the North Western Province of Sri Lanka.

H2: Knowledge & skill development has a positive impact on the systematic growth of ornamental fish exports in the North Western Province of Sri Lanka.

H3: Production cost has a positive impact on the systematic growth of ornamental fish exports in the North Western Province of Sri Lanka.

H4: Awareness of the market has a positive impact on the systematic growth of ornamental fish exports in the North Western Province of Sri Lanka.

3.1.3. Operationalization of Variables

Table 1: Operationalization of Independent Variables.

Variable	Dimensions	Indicators	Question Code	Question No.	Source
Ornamental aquaculture technology	Technical advice	Expert consultations	OAT01	08-10	(Nurlaili et al., 2021)
		Updated aquaculture techniques	OAT02		
		Sustainable practices	OAT03		
	Sufficiency of resources	Breeding facilities	OAT04	11-13	(Heenatigala, 2007)
		Adequate aquaculture equipments	OAT05		
		Financial resources	OAT06		
Knowledge & skill development	Training programmes	Government support	KD01	14-16	(Heenatigala, 2007)
		Communication skill development programs	KD02		
		Diversification of training sessions	KD03		
	Experience	Years of experience in the ornamental fish industry	KD04	17-19	(Yassien et al., 2022)
		Success in fish breeding	KD05		
		Adaptability to industry changes	KD06		
Language	Proficiency in international languages	KD07	20	(Sekharan & Ramachandran, 2004)	
Production cost	Good quality brooders	Healthy vitality of brooders	PC01	21-23	(Heenatigala, 2007)
		Genetic quality	PC02		
		Cost-effectiveness of brooders	PC03		
	Suitable labors	Cost of labor	PC04	24-26	

Awareness of the market	Quality feeds for fish	Reliable labors	PC05	27-29				
		Skilled workers	PC06					
		Availability of high-quality feed	PC07					
	Transportation	Cost of feed	PC08	30-32	(Sekharan & Ramachandran, 2004)			
		Nutritional content of feed	PC09					
		Cost of transportation	PC10					
	Overseas demand	Quality of transport facilities	PC11	33-34	(Heenatigala, 2007)			
		Safe packaging	PC12					
		Global market trends	AM01					
		Feedback from buyers	AM02					
		Barriers to market entry	Regulatory compliances			AM03	35-36	(Tarihora et al., 2023)
			Trade tariffs			AM04		
Available channels for accessing the export market		Number of distribution channels	AM05			37-39	(Banerjee et al., 2019)	
	E-commerce platforms	AM06						
	Trade show participation	AM07						

Table 2: Operationalization of Dependent Variable.

Variable	Indicators	Question Code	Question No.	Source
Systematic growth of ornamental fish exports	Production capacity	SG01	40-42	Developed by the researcher & (Heenatigala, 2007)
	Improved logistics	SG02		
	A wide variety of species	SG 03		

3.1.4. Research Design

Research Design includes the type of study, research approach, research strategy, etc. This research falls under basic research because it seeks to develop an understanding of a common problem in work settings. As this is quantitative research, it takes a deductive approach to draw logical conclusions and the researcher used a survey as the research strategy.

3.1.5. Sampling Procedure

The researcher studied the factors driving the systematic growth of ornamental fish exports in North Western Province, Sri Lanka. North Western Province consists of Kurunegala and Puttalam Districts.

Table 3: Ornamental Fish Exporters in North Western Province.

District	Number of ornamental fish exporters
Kurunegala	08
Puttalam	05
Total	13

Source: Export Statistics, Sri Lanka Export Development Board (2024).

Based on the records of the Sri Lanka Export Development Board, there are 13 registered ornamental fish exporters in the North Western Province, which was taken into consideration as population or the sampling frame. As there were only 13 ornamental fish exporters in North Western Province data was collected from all of them.

3.1.6. Data Collection

The primary data was collected using a structured questionnaire and addressed the purpose of the study. This study made use of a self-administered questionnaire to collect data from selected ornamental fish exporters who are from North Western Province. There are three sections of the questionnaire.

Table 4: Summary of Questionnaire.

Section	Area of Investigation/ Variable	Question No.
1	Demographic Information	1-7
2	Independent Variable	8-39
3	Dependent Variable	40-42

The 5-point Likert Scale was used as the method of measurement and scaling.

3.2. Data Analysis

The researcher used Statistical Package for Social Science (SPSS) to analyze the quantitative data and for this, the data cleaning method was also used.

4. Results and Discussion

The researcher identified that there were no missing values, after conducting the Missing Value Analysis.

4.1. Validity Test

According to the validity test results, it is confirmed that the data set is

adequate and valid since the significant value was 0.000.

4.2. Reliability Test

The researcher has identified that the overall questionnaire is reliable because Cronbach's Alpha value is greater than 0.70. All the independent variables and the dependent variables are in the range of 0.798 to 0.949. It shows that the questions used to measure all the variables were internally consistent.

4.3. Descriptive Analysis

Table 5: Descriptive Analysis of Dependent and Independent Variables.

	N	Mean	Std. Deviation	Minimum	Maximum
OAT	13	4.103	.889	1.50	4.83
KD	13	4.154	.792	2.14	4.86
PC	13	4.167	.751	2.00	4.83
AM	13	4.077	.744	1.86	5.00
SG	13	4.000	.933	2.00	5.00

According to Table 5, descriptive statistics show the mean, standard deviation, minimum, and maximum values of the dependent and independent variables. When considering the mean value of the data set, it shows 4.103 for Ornamental Aquaculture Technology, 4.154 for Knowledge and Skill Development, 4.167 for Production Cost, 4.077 for Awareness of the Market, and 4.000 for Systematic Growth. All the values are close to a high level, and it is revealed that these factors have highly impacted the systematic growth of ornamental fish exports. Standard deviations ranged from 0.744 (Awareness of the market) to 0.889 (ornamental aquaculture technology). It means the exporters' reactions were slightly different with respect to their views on each variable as shown by most measures within this range. All the variables had minimum scores of 1.50 to 2.14 and maximum scores of 4.83 to 5.00, showing the full range of possible responses. This analysis can provide a basic nature of the factors affecting the growth of ornamental fish exports within the data set.

4.4. Correlation Analysis

Table 6: Results of Pearson Correlation Analysis.

		SG	OAT	KD	PC	AM
SG	Pearson Correlation	1	.726**	.784**	.525*	.635**
	Sig. (1-tailed)		.002	.000	.033	.010
	N	13	13	13	13	13

OAT	Pearson Correlation	.726**	1	.726**	.833**	.861**
	Sig. (1-tailed)	.002		.002	.000	.000
	N	13	13	13	13	13
KD	Pearson Correlation	.784**	.726**	1	.769**	.836**
	Sig. (1-tailed)	.000	.002		.001	.000
	N	13	13	13	13	13
PC	Pearson Correlation	.525*	.833**	.769**	1	.863**
	Sig. (1-tailed)	.033	.000	.001		.000
	N	13	13	13	13	13
AM	Pearson Correlation	.635**	.861**	.836**	.863**	1
	Sig. (1-tailed)	.010	.000	.000	.000	
	N	13	13	13	13	13

** . Correlation is significant at the 0.01 level (1-tailed).
* . Correlation is significant at the 0.05 level (1-tailed).

These results show that knowledge and skill development and ornamental aquaculture technology have a strong correlation with the systematic growth of ornamental fish exports, and production cost and awareness of the market have a moderate correlation with the systematic growth of ornamental fish exports.

4.5. Multiple Regression Analysis

Table 7: Model Summary.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.896 ^a	.802	.703	.50807

a. Predictors: (Constant), OAT, KD, PC, AM

As per the results of the model summary and regression analysis for systematic growth of exports, the R square value is 0.802 (80%). It means that 80% of the variation in the systematic growth of ornamental fish exports (dependent variable) is explained by four independent variables ornamental aquaculture technology, knowledge and skill development, production cost, and awareness of the market. Also, it means that 20% of the variation in systematic growth of ornamental fish exports (dependent variable) is not explained by independent variables. According to ANOVA, the F value (model fitness) is 8.115 with a significant value of 0.006, which is less than 0.05. Overall, it is statistically proven that the model of fitness is available.

Results of the coefficients reflect the coefficients of multiple regression analysis and, a one-unit increase in ornamental aquaculture

technology (independent variable 1 – IV1) leads to an increase of 0.909 units in the systematic growth of ornamental fish exports (dependent variable – DV), with the error value of 0.346. The significant value is 0.030, which is less than 0.05, which can be considered a significant result. Given a beta value of 0.909, which exceeds 0.5 proves that ornamental aquaculture technology has a strong positive effect on the systematic growth of ornamental fish export.

An increase of one unit in knowledge and skill development (IV2), leads to an increase of 1.073 units in the systematic growth of ornamental fish exports (DV), with an error in value of 0.342. The significant value is 0.014, which is less than 0.05 and can be also considered as a significant result. Given a beta value of 1.073, which surpasses 0.5 proves that ornamental aquaculture technology has a strong positive effect on the systematic growth of ornamental fish export.

As per the results of the coefficients, production cost (IV3) has a negative relationship with the systematic growth of ornamental fish exports (DV). If one unit of production cost increases, it leads to a decrease of 0.701 units in the systematic growth of ornamental fish exports, with an error value of 0.420. The significant value is 0.134, which exceeds 0.05 and can be considered an insignificant result. The results show the awareness of the market (IV4) has also a negative relationship with the systematic growth of ornamental fish exports (DV). If one unit of awareness of the market increases, it leads to a decrease of 0.483 units in the systematic growth of ornamental fish exports, with an error in value of 0.521. The significant value is 0.381, which exceeds 0.05 and can be also considered an insignificant result.

4.6. Hypotheses Testing

Table 8: Summary of the Hypotheses Testing.

Hypothesis	B Value	Sig. Value	Result
H1: Ornamental aquaculture technology has a positive impact on the systematic growth of ornamental fish exports in the North Western Province of Sri Lanka	0.909	0.030	Hypothesis Accepted
H2: Knowledge & skill development has a positive impact on the systematic growth of ornamental fish exports in the North Western Province of Sri Lanka	1.073	0.014	Hypothesis Accepted
H3: Production cost has a positive impact on the systematic growth of ornamental fish exports in the North Western Province of Sri	-0.701	0.134	Hypothesis Rejected

Lanka			
H4: Awareness of the market has a positive impact on the systematic growth of ornamental fish exports in the North Western Province of Sri Lanka	-0.483	0.381	Hypothesis Rejected

The study clearly revealed that both ornamental aquaculture technology and knowledge and skill development have a significant and positive impact on the systematic growth of ornamental fish exports. The multiple regression analysis results demonstrated that these two variables are statistically significant. It confirmed that the exporters with better access to modern technologies, knowledge, and skills are more likely to grow their businesses. On the other hand, production cost and awareness of the market, although positively correlated with the systematic growth of ornamental fish exports in North Western Province, were found to be statistically insignificant in the multiple regression analysis. It indicated that though these factors are significant, their influence on the current growth dynamics is below average. The correlation between production costs and export growth was moderately positive and it indicates that high costs could be obstacles to growth. Additionally, the low significance of awareness of the market indicates inefficiencies in the acquisition and application of market intelligence, which might be enhanced by more effective export promotion plans and market access programs.

This study underscores the requirement for integrated interventions that simultaneously enhance aquaculture technology, knowledge and skills, and market access. Government and industry stakeholders should pay attention to support through training programs, developing infrastructures, and export incentives. This will not only address the current challenges but also create a more sustainable path for growth by ensuring that the ornamental fish exporters in the North Western Province can compete effectively in the global ornamental fish market.

5. Conclusion and Implications

Although the variables of production cost and awareness of the market were correlated with the systematic growth of ornamental fish exports, the results of multiple regression analysis revealed those two variables were insignificant to the systematic growth of ornamental fish exports. Overall, from the above findings, it is confirmed that the development of aquaculture technology and the development of knowledge and skills among exporters and fish farmers provide the foundation for the systematic growth of ornamental fish exports in the North Western Province of Sri Lanka.

Among the recommendations, the first is that since the

ornamental fish industry is a sector that contributes a lot to Sri Lanka's export market, the relevant institutions should show more intervention to protect the ornamental fish exporters and farmers. New entrants to the ornamental fish industry should have the opportunity to enter this market and thus provide an incentive to expand the new market. In addition, the responses received in this study show that the expert support required for ornamental fish breeding, growing, and export should be further honed. The attention to the development of knowledge and skills for these are essential. There is a great need for programs on market knowledge and market strategies to increase the foreign exchange that the country receives from the export of ornamental fish, to pave the way for the success of the industry.

Several limitations were identified in conducting this study. A major limitation that arose here is the lack of sufficient literature on the export of ornamental fish in Sri Lanka. Some of the findings were limited to the Colombo District in the Western Province of Sri Lanka and had no relevance to the North Western Province. In addition, it was difficult to find information related to the export of ornamental fish because it was constantly changing. Another limitation is obtaining accurate data on ornamental fish exports.

The sample size of this research was very small and consisted of 13 exporters. For a more successful study, it is advisable to choose a value greater than 100. Also, in this study, ornamental aquaculture technology, knowledge and skill development, production cost, and awareness of the market are identified as the primary factors influencing the systematic growth of ornamental fish exports and there may be other strong factors influencing the systematic growth of ornamental fish exports. Therefore, potential researchers can research to examine the effect of variables not examined in this study in different regions, thereby further improving the scope of the study. In addition, since two variables were rejected in this study, it is clear that some inconsistencies have occurred. It is therefore recommended that further research be conducted to find out the impact of production costs and awareness of the market on the ornamental fish industry.

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