Conceptual Framework for Innovation Product and Marketing Strategy at Precast Construction Company in Indonesia to Increase Competitiveness Using SWOT and Neural Network Model

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Abstract

The competitiveness of national infrastructure is influenced by the strength of the precast concrete industry, leading to the need for its productivity to be boosted. Although many interminable challenges have been unfolding, the domestic precast concrete companies are presently attempting to penetrate the foreign markets through thorough preparation, specifically in organizational competitiveness. This is due to their potential competition with a wider market, compared to the domestic. The number of foreign construction companies, specifically precast concrete services, also continues to grow in the Indonesian domestic market and largely occupy business fields, due to the low competitiveness of local organizations, which has been identified as a future potential threat. Therefore, this study aims to analyze the competitiveness of local companies in the Indonesian domestic market. This needs to be highly evaluated as well as importantly and carefully planned to avoid low organizational competitive levels. A qualitative method was used with SWOT analysis and neural network mapping, which were supported by previous literature. The results show that precast products and marketing strategies should be able to have long-term planning in achieving market size, for the minimization of external threats.

Keywords
Neural Network, Product, Marketing Strategy, Precast and Competitiveness

1. Introduction
Precast concrete is a new innovation widely used in construction processes, such as buildings and bridges, due to its ability to speed up processing time, save costs, and minimize waste for formwork and scaffolding (Reichenbach and Kromoser 2021). This innovation is one of the construction systems in accordance with the Industry 4.0 concept. The precast system is listed in SNI 03-2847-2002 (Badan Standardisasi Nasional 2002), with the procedure for calculating concrete structures based on ACI 318-99 (Cagley et al. 1999). The development of Indonesian facilities and infrastructures, which is still in progress, has been consuming enormous investments, therefore, organizational competitiveness is highly needed for successful management (Stoyanova and Angelova 2018). This is because the country's 4.73% economic growth is still far from expectations as of September 2015, with a minimum of 7% level being needed for the achievement of a developed nation in 2025. When the infrastructural situation of a country is weak, the economy is observed to be inefficiently operated (McBride et al. 2003). In this condition, higher costs are considered to cause inadequate competitiveness among numerous companies and businesses (Arai 2022). The infrastructural provision within the country is also observed to be slow, due to the occurrence of challenges at various stages of the project, from preparation to implementation. Some physical examples of these infrastructures include

ordinary and toll roads, stadiums, bridges, buildings, electricity networks, dams, etc. To support this development, various design materials are needed including precast concrete, which is utilized due to being an important part of the construction (Ko 2013). The practicality and easy installation of this product are one of the reasons it is often needed. Various kinds of innovative methods are also used, including the cast in situ and precast, e.g., the use of long PPCPs (prestressed precast concrete piles), which was developed by Fiber Reinforced Polymer (FRP) (Khedmatgozar Dolati and Mehrabi 2022). To reduce production costs, the work-in-process (conwip) construction method is reportedly used due to being able to minimize costs by 24% of the workforce (X. Li et al. 2018). A total of 46 business actors are found in the Indonesian precast industry, where 5 and 41 of them are owned by the BUMN and the private sector, which performs systematic procedures with the occurrence of challenges.

To improve organizational performance in infrastructure construction projects, the application of a management system is one of the efforts developed toward increasing competitiveness in this globalization era. In this condition, the company's competitive advantage is based on the leadership excellence of the project manager. According to Soeparto and Trigunansyah (2005), the causes of low competitiveness regarding small productivity are mainly due to the following, (1) inappropriate placement of workers, (2) low technical intensity, (3) inadequate coordination between construction business actors, i.e., no cooperation is observed in resource utilization, operational, marketing, as well as development and experimental cooperation, (4) inaccurate functioning cooperative institutions between construction service actors, government, and universities, (5) unhealthy structure and competition, (6) non-optimal abilities of the construction business manager, (7) the sophisticated demand of service users regarding quality and time, (8) unideal industrial structure, and (9) high transaction cost. Therefore, this study aims to analyze competitiveness as a dependent variable, with the products, systems, methods, and marketing strategies being independent. This is conducted to measure the influential variables between product and marketing strategies, towards the increase of competitiveness. Competitiveness is also expected to improve when it becomes a precast company culture, leading to the development of innovations.

1.1 Objectives
The high competitiveness of a country is needed due to leading to the great productivity of its citizens. This causes the attraction of foreign investment, which stimulates the economy, as well as demonstrates the ability to maintain economic stability and resilience from a possible recession. Competitiveness is also closely related to innovation, which main goals involve the creation of different ideas from the competitors in similar fields. This indicates that during a company's innovation on a product, special uncommon market advantages or specifications are highly needed. These conditions lead to the need for an analytical contribution, regarding the methods of increasing the competitiveness of products and marketing strategies for precast organizations. This is expected to affect organizational performances, leading to the development of an innovative culture. Therefore, the study aims to develop product and marketing strategies for Indonesian construction companies to increase competitiveness through SWOT analysis and neural networks.

1.2 Conceptual Framework
Various related factors are found to produce an organizational competitive value, specifically in core Indonesian precast companies. In this condition, several interrelated concepts of work management, product processes, and policies were observed, regarding the increase of these company values. Subsequently, these interrelated relationships were adopted from a survey of several leading precast organizations within the country. The conceptual framework emphasizes critical thinking, which structure focuses on the systematics and tools used in solving problems. Integration is also described in this framework as follows:
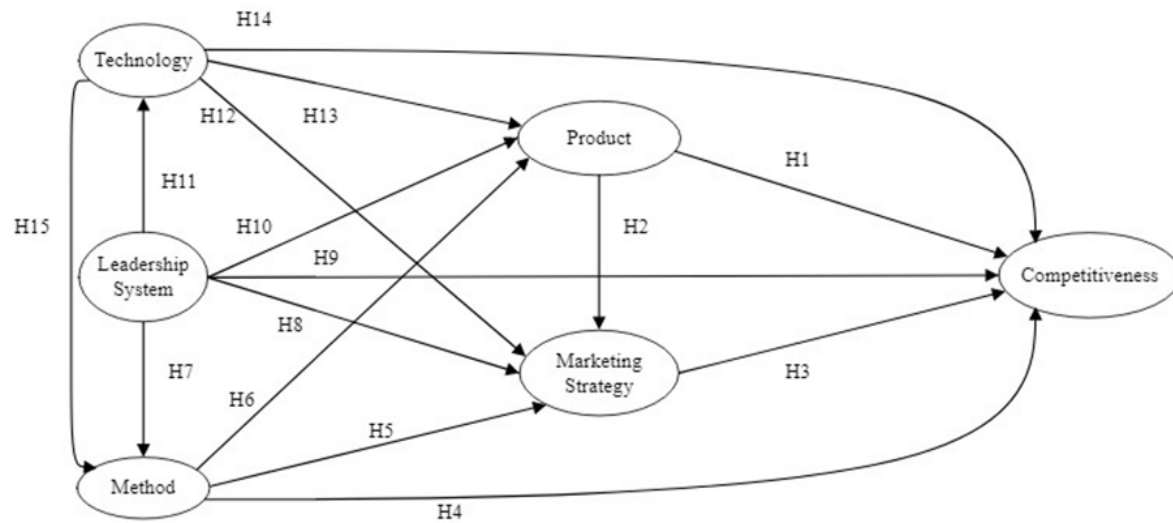
Figure 1. Conceptual Framework

Based on Figure 1, the relationships within the precast companies were observed, with the conceptual design being analyzed according to the flow of Technology, Leadership system, and Method toward Product and Marketing Strategy, respectively. The procedure involved during innovation includes the following, (1) utilizing existing technology, (2) creating different unique products, (3) improving services, and (4) enhancing human resource capabilities (Andansari 2018). This showed that the business companies whose production strategies are oriented towards customer desires are able to survive during any competition, leading to the following hypothesis,

H1: Product innovation has a positive influence on competitiveness.

Based on superiority, the uniqueness, packaging, and cost-efficiency of product innovation are able to increase competitiveness through imitability, durability, ease of matching, and marketing. These processes are carried out by the production and marketing entrepreneurs, through the selling and provision of the products closer to the customers (Karinda et al. 2018). This indicates that better innovation causes greater marketing performance, leading to the following hypothesis,

H2: Product innovation has a positive and significant effect on marketing performance.

This indicates that higher innovation led to better marketing performance. According to (Kokoh et al. 2021), the design of a competitive marketing strategy began with the analysis of competitors. The company also compared close competitors through customer value and satisfaction, using valuable products, prices, promotions, and distribution (marketing mix). In this condition, the development of a competitive strategy was observed between the internal and external forces through a matching process. This condition leads to the following hypothesis,

H3: Marketing strategy has a positive influence on competitiveness.

Marketing strategy is often used to direct all business activities during strong competition and a changing environment (Rizka Bella 2021). This explains that innovation is manifested in new product designs, production processes, marketing approaches, or methods (Schwab 2017). At an innovative stage, many countries are also found to only sustain higher wages and standards of living based on the competitive levels of their businesses, through the provision of new or unique products.

2. Literature Review

2.1 Competitiveness

Competitiveness is the ability to achieve dominance and stability between individual firms and the economies at the micro and macro levels, respectively (Márkus 2017). This concept is divided into 3 (three) hierarchical levels, namely country (macro), the industrial sector (meso) and company (micro) (Momaya and Selby 1998). In the construction industry, some of competitiveness causes include human resources (qualified staff), financing, communication, as well as strategy and production technology (Stoyanova and Angelova 2018). According to Maruf and Ratnaningsih (2020), this concept was influenced by several internal factors, such as company finances, markets, technology, and facilities. However, the external factors included financial economic and political stability, cooperation, project availability, R&D, and government policies. This was not in line with Moazzam et al. (2020), where the following influenced the competitive concept, (1) construction industry environment, (2) company level competition, (3) organizational potentials, (4) supporting factors' competitiveness, (5) company flexibility, (6) economy, and (7) finance. Huda et al. 2018) also indicated that the causes of competitiveness were influenced by the internal environment, such as financial, organizational, physical, human resources, innovation, reputation, and project management. Meanwhile, the influenced industrial environment included the following (1) competition with contractors, (2) threat of foreign contractors' entries, and (3) suppliers' bargaining power, with effects subsequently observed on environmental external scanning, monitoring, forecasting, and assessment. Based on these reviews, the concept of competitiveness is defined as the level or ability of productivity to formulate strategies with the capabilities to achieve excellence over other competitive parties. This is carried out by a group or an institution and influenced by the competitive resources and environment.

2.2 Product

Precast products are the concrete elements with or without moulded reinforcements, which are initially observed before being assembled into buildings (SNI 7833: 2012). In construction processes, the examples of popularly used precast innovations are buildings and bridges, due to the concrete's ability to speed up processing time, save costs, as well as minimize waste materials based on being sources of losses (Z. Li et al. 2014). This waste minimization is then used in the formulation of formwork and scaffolding. In its development, construction products are reported to be developed very rapidly, as observed in the I beam precast products (Tegos et al. 2013). This proved that many innovations have been created with the consideration of each product's competitiveness. To keep precast concrete in a stable competitive position, several innovative considerations include the excess supply capacity, regarding the rapid increase of the product's present national demand (C.-H. Ko 2021). The ability to produce these goods is also related to a unique and secretive technology, where product quality improvement is used to overcome the business network weakness and market penetrability. This is because good quality leads to the production of greater competitive market products. According to Syifa et al. (2019) , the advantages of new products were very important in a highly competitive global circle. The results showed that the developed product innovation produced greater advantages, compared to others. This development was carried out through product excellence, uniqueness, packaging, and cost-efficiency, to increase competitiveness through imitability, durability, and marketing. Based on this review, the product concept is often produced by the company, to improve competitive uniqueness and quality.

2.3 Leadership System

Increasing competitiveness enables easier market share expansion, where a leadership system is needed to overcome the competitive level of the precast concrete industry. This system aims to stabilize the competitive strategy of an organization. Among the factors affecting competitiveness, several human resource indicators were observed (Stoyanova and Angelova 2018), where a leadership system variable was determined according to the requirements of a competition (Latham, 2013). In Abernethy et al. (2010), an effective leadership system included the mechanisms for leaders to conduct self-examination and development processes, as well as obtain feedback. Regarding proficient efficiency, this system is designed to increase the effectiveness of individual and collective leadership of clients (Ndalamba et al. 2018). Agile governance systems are also one of the methods of increasing world-class competitiveness, which creation requires dynamic work unit leaders. Based on Senge et al. (2015), a leader needs to understand the problems existing within the entire organization. This indicated that a change leader needs to be able to embrace, provide, and invite the subordinates towards a better direction. In this condition, a leader's communication skills are also important. Furthermore, a leadership system is a collection of various performance subsystems/components, which are interrelated, dependent, and interactive with one another. These are harmoniously coordinated to influence and motivate a group of individuals, as a media to master the work and professional level of regularly conducting tasks, towards the achievement of goals (Citra 2021). From this literature, the concept of a

leadership system is based on a series of processes, which emphasizes the performance patterns of effective development and improvement. This includes the developmental methods of decisions, communicating, strengthening direction, etc. In the present situation of Indonesian precast companies, the leadership system is often adjusted every time a manager or director is replaced. During this period, the systematic changes affecting the company's performance are also observed. By developing a consistent system with no effects on leadership changes, the company's competitiveness is expected to survive and expand in the long term.

2.4 Method

The method of the precast system is effective in answering the needs of this era due to casting several components in a special place (fabrication), as well as providing and arranging them into a specified location and complete structure (transportation and erect), respectively (C. H. Ko 2010). The advantage of this concrete system includes (a) guaranteed quality, quickness, and mass production, (b) fast development, (c) environmentally friendly, and (d) neat with good product quality. Moreover, two concrete implementation methods are presently observed, namely the precast and the conventional techniques, which are widely used in Indonesian construction projects. The precast method emphasizes the reinforced or unreinforced concrete parts, which are cast in progressive positions asides from the final point, during construction. Meanwhile, the conventional method involves casting on similar positions at the end of the building activity. This proves that the method concept emphasized the steps conducted in the production of an effective and efficient organizational process.

2.5 Technology

In technology, the competitiveness of a country is always an interesting topic in the economic, political, social, and technological fields (McBride et al. 2003). This is considered one of the resilient sources used to confront all challenges in the development of civilization. The development of this element is presently very fast, specifically for high-strength concrete. In this condition, various studies and analyses were carried out to improve the quality of concrete, material technology, and implementation techniques (Hidayawanti et al. 2019). One of these efforts involved the use of precast technology, which was suitable to increase efficiency regarding construction cost, quality, and time. This indicated that infrastructures often used many concretes for varied constructions, as well as the reduction and production of costs and better quality (Ye et al. 2021). Precast systems have also been domestically and internationally developed, as well as widely applied in Indonesia. Furthermore, the achievement of sustainable competitive advantage is carried out through technological differentiation, with the concept of this strategy and innovation being important in formulating business strategies. The interaction between technology and labour is also understood based on their respective roles in creating innovation, efficiency, and business productivity (Jacinto et al. 2017). From several related studies, conceptual technology is defined as a strategy in formulating business, as its interaction with labour is comprehended regarding their respective roles in creating innovation, efficiency and business productivity.

2.6 Marketing Strategy

Marketing strategy is one of the methods used to win a sustainable competitive advantage for business organizations. This activity is specifically used to boost the acceptance of the marketed goods and services. It is also very similar and inseparable/from the element of competition. According to (Syifa et al. 2019), the design of a competitive marketing strategy began with the analysis of competitors. In this condition, consumers were observed to previously obtain most product information traditionally, compared to the present utilization of e-marketing for a new shopping experience (Yuan 2013). Based on the results, all business organizations need to be highly competitive for survival (Olson et al. 2021). The function of marketing strategy also emphasizes the determination of the nature, strength, direction, and interactions between the mixed elements and environmental factors in a specific situation (Cespedes and Piercy 1996). Through a careful analysis of various changes, sustainable efforts provided a complete understanding of marketers, which was useful in appropriately pushing the business in a good direction. This analysis was able to observe the forces of change from very important to unimportant rankings, due to having a significant impact on organizational activities. These forces included the political, technological, socio-cultural, and economic phenomena, as well as the competitors. This was in line with the sustainable analysis directing business abilities towards survival in a constantly changing and increasingly competitive market. Therefore, marketers need to always carry out progressive adjustments toward the design of strategies, programs and values. Marketing is also a scientific discipline, which is used to periodically create optimal value for stakeholders. When value changes occur, the marketing concept is observed to be continuously changing according to the stakeholder demand and market development transformations. This strategy is also inseparable from the element of competition, indicating that every actor is required to always innovate its business competitively (Rizka Bella 2021). Based on this literature, the concept

of marketing strategy was inseparable from the element of competition, specifically in competitive business organizations. This was observed by considering competitive marketing strategies through the analysis of competitors with mix and external factors. In addition, this strategy is one of the methods used in winning competitive advantages through the determination of organizational nature, strength, and direction, to confront strong competition and a frequently unstable marketing environment.

2.7 SWOT Analysis

This is a major business tool for strategic planning, which has been functional for more than six decades. Using an integrative literature review, a greater understanding of this analysis was provided in various sectors with different experimental approaches (Benzaghta et al. 2021). This proved that a SWOT analysis was often used to increase the competitiveness of a company. The results were in line with Abdul Manaf et al. (2013), where the improvement of product competitiveness quality in Malaysia yielded halal-certified products. Husin et al. (2021), Md Husin and Haron (2021), Rojas (2018) also used the analysis for business competitiveness in the logistics sector. In addition, the SWOT approach was used in the fields related to the improvement of business innovation Zhang and Rao (2021), Harbar et al. (2020), Tetiana and Yaroslavna (2020). Based on the results, this analysis was widely utilized in business fields, based on the perception of organizational management. Using the SWOT analysis, the contribution formula of each variable is shown as follows:

$$\frac{X_{S,W,O,T}}{X_S+X_W+X_O+X_T} \times 100\% \tag{1}$$

2.8 Artificial Neural Network (ANN)

ANN is a computational model inspired by the structure and function of biological neural networks, which are expected to differently handle problem-solving, compared to a conventional recording. In this condition, a distinction is often carried out between patterns and data, to emphasize the need for developing a processing system, for coping with the task of recognition. Subsequently, this basic network and the principles of ANN lead to the development of architectures for complex pattern recognition tasks (Yegnanarayana 2021). The use of ANN has been widely carried out in various scientific fields, due to possessing more capabilities to perform classification, prediction, projection, and segmentation functions, which are popularly and heavily relied on for problem-solving. Based on its applications in competitive fields, the contesting power of a company to the competitiveness of the country was observed in Ülengin et al. (2011), Önsel Ekici et al. (2016), Kolkova (2020), Lou et al. (2020), Rahmat and Sen (2021). The implementation of this network in the fields related to the increase in product innovation was also found by Kinne and Kinne and Lenz (2021), Wang et al. (2021), Y. Li et al. (2021), Alves and Martins Oliveira (2020), Novia et al. (2020), Noppakorn Klintong, (2017). In this present study, an ANN model with the ability to generate a competitive organizational value was developed, using the properties of the network's classification function. This utilized model is known as the Linear Vector Quantization (LVQ), which produced a qualitative value.

2.9 SWOT and Analysis Neural Network Model

The development and combination of the ANN and SWOT models are often used to solve casuistical problems. To assess the competitiveness of products, several studies were observed to combine the SWOT and the Analytic Hierarchy Process (AHP) models, such as Fahim et al. (2021), Hamirudin and Prasetya (2021), Taufiqu Rochman et al. (2011), Lee and Chung (2018). Based on existing reference analysis, an ANN-SWOT hybrid model was used by very few reports, namely Alizadeh et al. (2021) and Sinha and Abernathey (2021). However, several reviews were related to seismic assessment, sea level estimation , and the development of SWOT analysis for customer satisfaction (Phadermrod et al.). In the automotive product industry, a similar model was also developed by Kumari and Bhat (2021), where the results obtained were prepared for mapping and normalizing data values as input for the ANN system. In this condition, the system processed the input with the LVQ algorithm until a specific value was obtained. Subsequently, this value was observed to be sufficiently or insufficiently qualitative in the classification of good values.
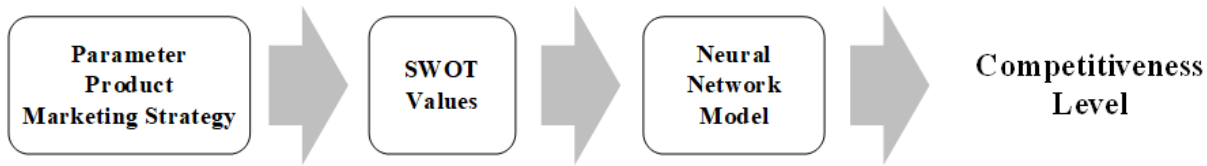
3. Methodology

Figure 2. Study Methodology

3.1 (Parameter/Variable) Product and Marketing Strategy

The implementation of the conceptual framework was developed in the neural network model, where the parameters for evaluating the competitive level of a company were from the precast product flow and sales strategy. These parameters emphasized three strategies, namely: Technology, Leadership, and Methods, which were assessed by each Indonesian company. This was due to the complete relationship between these strategies on product and the marketing strategy, using the SWOT model assessment, which was mapped and normalized as input to the neural network systematic formulation. The final result was in the form of three competitive value classifications, namely Very Good, Fairly Good, and Good.

Product

Precast products are the final outputs of a production process, which required ordinary and predetermined standard-reference raw materials. In this condition, the factors influencing the quality of competitive products were also technology, good/appropriate leadership and decision-making patterns, as well as methods.

Marketing Strategy

This construct is important to marketing practice and was observed at the conceptual heart of the strategic field. It also required a large amount of information, to appropriately match consumer expectations and needs, regarding the selection of a suitable strategy. In line with the product parameters/variables, the marketing strategy emphasized the existence of technology, leadership, and methods.

SWOT Values

The assessment of these values calculated the contribution of the company's strengths (S), weaknesses (W), opportunities (O), and threats (T). The value of each SWOT parameter was then prepared as an input for the neural network system.

Table 1. SWOT Mapping

Variable	Correlation	Parameter	S W O T			
			S	W	O	T
Product	Technology	H13	S6, S10			
	Leadership	H10	S11	W10		T6, T7, T8
	Method	H6		W1, W2, W6,	O4, O5	T4
Marketing Strategy	Technology	H12	S9	W3, W4, W5, W7	O2, O6	T2, T5
	Leadership	H8	S3, S8	W9, W11	O3, O7	T1, T3
	Method	H5			O1	

Based on Table 1, the SWOT values focused on the in-depth analysis of a company as the conceptual framework flow, towards the H5, H6, H8, H10, H12, and H13 variables. These parameters indicated a standard model (robust) when the company's competitive value was only considered from the product and marketing strategy aspects. Moreover, 6, 10, 7, and 8 variables were observed for S, W, O and T, respectively. The SWOT value mapping was also prepared as an input for ANN, where the nominal unit of numeric information was normalized to facilitate data processing in the neural network architecture. In this condition, normalization is carried out by mapping the numbers between 0 and 1 as follows:

$$X_{Map} = \frac{X_{Original} - X_{min}}{X_{max} - X_{min}} \qquad (2)$$

Where :
X_{map} = Normalized Value
$X_{Original}$ = Original Value
X_{max} = Maximum Value Registered
X_{Min} = Minimum Value Available

Neural Network

This was observed as a computational model, through the structure and function of biological neural networks, which differently handled problem-solving than conventional computation. In this process, a distinction was conducted between patterns and data, to emphasize the need for developing a processing system for coping with recognition. This was accompanied by the normalized SWOT values, which were then inputted into the neural network system. The assessment mechanism was also carried out using a linear vector quantization (LVQ) model. Based on the SWOT value data pattern, the neural network performed a function to qualitatively categorize a company's competitive value status. Regarding the principles of the conceptual framework, the compiled final result of the neural network model then provided an organizational assessment, which placed a company in the Very Good, Fairly Good, and Good levels.

Learning Vector Quantization

Learning Vector Quantization (LVQ) is one of the widely used Artificial Neural Network (ANN) models. This emphasized the prototype of a supervised learning classification algorithm, with its network trained through a competitive system similar to the Self-Organizing Map. To assess the deviations in the data sample with a specific density, a clustering technique was used as a classifier, where the evaluation showed that performance remained the same with almost all combinations of training and testing (Sahoo et al.). Learning was then carried out by calculating the euclidian distance as follows:

$$d(\vec{x}, \vec{w_k}) = \min d(\vec{x}, \vec{w_k}) \qquad (2)$$

Wk (weight improvement) was also used to determine the weight (w), which distance value (d) was the smallest as follows:

$\vec{w_k} \leftarrow \vec{w_k} + \eta.(\vec{x} - \vec{w_k})$, when c_m = y, it is relatively close,

or $\vec{w_k} \leftarrow \vec{w_k} - \eta.(\vec{x} - \vec{w_k})$, when $c_m \neq$ y, then it is part of the set.
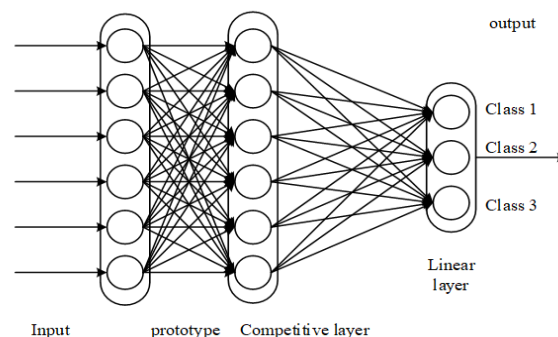

Figure 3. Neural Network Model

4. Result and Discussion

Based on these results, the H5, H6, H8, H10, H12, and H13 parameters were obtained from a precast construction company in Indonesia and measured by SWOT analysis, leading to 6, 10, 7, and 8 variables for S, W, O and T. These results were then categorized into the following 3 Outcome Scenarios.

The Outcome Scenario 1 had the ANN model output values that nationally had a high competitiveness parameter based on the best product and marketing strategy. In this condition, the observed correlations stated that the companies with a strong S value had low, large, and small of W, O and T parameters, respectively.

The Outcome Scenario 2 had the ANN model output values with good competitiveness parameters, which were not nationally high regarding the product and marketing strategies. In this condition, several possible SWOT values were observed, e.g., the companies with a strong S value had low, large, and small of W, O, and T parameters, respectively. However, when using range value calculations, these parameters were sufficiently large as observed in Scenario 1. This led to another option where a company with insufficient competitors was functional in a small area, indicating that the values of T and O were very low and high, respectively.

The Outcome Scenario 3 had the ANN model output values with good competitiveness parameters, which were not nationally better than those in the previous scenarios. This occurred in the companies having the opposite and below-average values of Scenarios 1 and 2, respectively. These results are subsequently shown in Table 2.

Table 2. Result Model SWOT ANN Competitiveness Index

S	W	O	T	Index	
H	L	H	L	High Competitive Company	1
MH	ML	MH	ML	Medium Competitive Company	2
ML	MH	ML	MH	Medium Competitive Company	
L	H	L	H	Low Competitive Company	3

Where :
L = Low
ML = Medium Low
MH = Medium High
H = High

Based on each SWOT parameter of the 31 variables (S+W+O+T = 6 + 10 + 7 + 8 = 31), the contribution of the competitiveness value was S, W, O, and T = 19.4%, 32.3%, 22.6%, and 25.8%, respectively. This confirmed the importance of decreasing the values of W and T, to increase the competitiveness values according to the ANN mechanism in Table 2.

5. Conclusion

Based on product and marketing strategies, the development of a conceptual framework model used the combined SWOT and ANN model to determine the classification of competitiveness values. This proved that the SWOT-ANN model was accommodated and used in a formulation, by knowing the amount needed to innovate products and marketing strategies. This model was developed based on the 6, 10, 7, and 8 variables for S, W, O and T, respectively. Subsequently, these variables were developed by accommodating the interests of improving product and marketing strategy qualities. From Table 2, the improvements in product quality and marketing strategy also contributed greatly to the increase in organizational competitiveness.

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