Key Success Factors and Entrepreneurial Orientations of The Beneficiaries of the One Town, One Product (OTOP) Program in the Province of Tarlac

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ABSTRACT

This research aimed to describe the key success factors and entrepreneurial orientations of the beneficiaries of DTI OTOP Program in the province of Tarlac. The descriptive/correlational research was employed with 30 respondents. Half of the 30 businesses surveyed have 10-99 employees. Majority was earning revenues of PhP 5,000,000.00 or less and has recently invested PhP 5,000,000.00 or less. The entrepreneur and enterprise key success factors were extremely important to the respondents, network is very important and business environment is mildly important. The entrepreneurs are neutral on innovativeness and competitiveness, highly proactive, risk takers, and not practicing autonomy. The entrepreneur, enterprise, and business environment have relation to employment generation, as does the enterprise with sales. Innovativeness and risk taking have a positive effect on employment generation, and higher significance on sales. Risk taking has high significance to investment. The entrepreneur, enterprise, and business environment KSFs impact employment generation, and network to sales and investment. Innovativeness and risk taking have a direct influence on employment generation, while innovativeness, being proactive, risk taking, and competitive aggressiveness have a positive impact on average sales and investment. This study supports the relevance of success factors and entrepreneurial orientation towards the attainment of good business performance.

Keywords: key success factors; entrepreneurial orientations; one town, one product (OTOP) program, enterprises

I. INTRODUCTION

Small and medium size firms make up a large component of the business sectors of the developing countries, including the Philippines. In the 2013 figures provided by the Philippine Statistics Authority (PSA), the Philippines has a total of 941,174 businesses comprising of 99.6% micro, small, and medium enterprises (MSMEs) and 0.4% large enterprises.

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The significance and gravity of contribution of the small and medium sized businesses make them a very indispensable part of the economic sector of every country. Governments from around the world came up with some projects benefiting the small businesses to further help them survive and continue improving the economic output, employment, as well as the preservation of culture through the manufacture of local products. A very good model of assistance to SMEs was the OVOP (One Village One Product) in Japan.

The need to support local businesses has prompted other countries to study the model of OVOP Program of Japan, and they were inspired by the results. To date, OTOP programs were implemented in South Asian countries, including the Philippines.

OTOP-Philippines is a multi-sectorial program of the Philippine government, which started in 2004, which aimed at assisting local businesses, and involving the national government agencies (NGAs), local government units (LGUs), and the private sector. The assistance package available to entrepreneurs includes business counseling, skills and entrepreneurial training, latest technologies, marketing, and product designs and development.

The OTOP Program has significantly produced outputs during the incumbency of President Gloria Macapagal-Arroyo and President Benigno Aquino, Jr.

The assistance given to small and medium sized businesses by the government and private sectors has apparently given them the leverage to grow and prosper. The success of many businesses may also be attributed to the personal characteristics of the people who manage them, or they may have prospered by effective financial management, innovation, adaptation, and planning. Or it may be because of a recipe for success that come from the entrepreneur, the business itself, the people around, or the environment where the enterprise operates. These may be collectively called key success factors or KSFs.

Aside from the key success factors, another idea that could possibly contribute to the growth and success of an enterprise is the entrepreneur's orientation.

Entrepreneurial orientation (EO) is a description of how a firm formulates or chooses its strategies based on managerial philosophies. Through the years, entrepreneurial orientation has become one of the most studied concepts in the field of entrepreneurship. The first researches on EO have identified the core ideas of innovativeness, proactiveness, and risk-taking as possible orientations on entrepreneurial strategy formulation. Past researches uncovered the significant influence of EO on the performance of the firm.

The entrepreneur himself defines the entrepreneurial orientation of a firm because

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in the first place, he is the decision maker. It is like the personality of the business itself.

The Province of Tarlac has been a recipient of the OTOP program of the Department of Trade and Industry. In its initial six (6) year run that is from 2004-2010 the project has unquestionably produced successful businesses. Some of the well-known OTOP products of Tarlac are iniruban, sweet potato products, bamboo products, sugarcane, and chicharon, among others. Some of these products have turned as inspirations in coming up with local festivals, the most popular of which is the Chicharon Festival in the town of Camiling.

This study was conceptualized primarily to describe the key success factors and entrepreneurial orientations of the entrepreneur-beneficiaries of the OTOP Program in the Province of Tarlac in the hope of providing a recipe for success for budding and existing entrepreneurs in the area.

Statement of the Problem

The main problem of this research was to describe the key success factors and entrepreneurial orientations of the beneficiaries of the DTI OTOP (One Town, One Product) program in the province of Tarlac.

More specifically, it sought to give light on the following queries:

1. How are the businesses of the beneficiaries of the OTOP program in the Province of Tarlac described on:
   1.1. employment generation;
   1.2. average sales for the past three years; and
   1.3. amount of investment?
2. How do the beneficiaries of the OTOP Program describe the key success factors (KSFs) clustered according to:
   2.1. entrepreneur;
   2.2. enterprise;
   2.3. network; and
   2.4. business environment?
3. How are the entrepreneurial orientations of the beneficiaries described along:
   3.1. innovativeness;
   3.2. proactiveness;
   3.3. risk taking;
   3.4. competitive aggressiveness; and
   3.5. autonomy?
4. How do the performance variables of the businesses relate to:
   4.1. key success factors; and

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4.2. entrepreneurial orientations of the beneficiaries?

5. To what extent do the key success factors and the entrepreneurial orientations influence the performance of the businesses?

6. What is the implication of the study to Business Administration?

Hypothesis

From the statements of the problem, the following hypotheses were hereunto tested.

Ho1 There is no significant relationship between the performance variables and the key success factors and entrepreneurial orientations of the OTOP beneficiaries.

Ho2 The key success factors and the entrepreneurial orientations of the OTOP beneficiaries have no significant influence on the performance of their businesses.

II. METHODOLOGY

The descriptive/correlational research was employed in this study. When it comes to sampling design, complete enumeration was used.

The researcher used the questionnaire in gathering data. The tool was divided into two parts: the first part is for the SMEs and the second part catered to the entrepreneurs.

The respondents in this study were the 30 successful entrepreneur-beneficiaries of the OTOP Program in the province of Tarlac.

The data were processed using statistical tools such as percentage, frequency, ranking, mean and standard deviation to aid in data analysis. The information was presented in tables to facilitate easier interpretation by the researcher.

For the relationship between two variables, more specifically performance with entrepreneurial orientations and performance with key success factors, the Pearson's correlation coefficient was used. Analysis on the possible causation between success factors and performance and between entrepreneurial orientation and performance were also determined using multiple regression analysis.

In the interpretation of the results in key success factors and entrepreneurial orientations, the following were utilized.

Importance Scale and Verbal Descriptions

Average Rating	Verbal Description
1.00-1.49	Not important
1.50-2.49	Not very important
2.50-3.49	Mildly important
3.50-4.49	Very important
4.50-5.00	Extremely important

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Entrepreneurial Orientation Scale Average Ratings and Verbal Descriptions

Entrepreneurial Orientations Scale Average Ratings	1.00-2.19	2.20-3.39	3.40-4.59	4.60-5.79	5.80-7.00
Verbal Descriptions	Very low	Low	Moderate	High	Very high

III. RESULTS

1. Performance of the Businesses

1.1.Employment Generation

Table 1 shows the firms' performance on employment generation.

Table 1

Employment Generation

N=30

No. of Employees	F	%
10-99	15	50
1-9	14	46.67
100-199	1	3.33
Total	**30**	**100**

Out of the 30 businesses surveyed, there were 15, which have 10-99 employees, while 14 were employing between 1-9 people. Meanwhile, there was one business with more than a hundred employees. This is the crochet business in the town of Ramos, Tarlac, which, at its peak of operations, has given employment to 150 people in the barangay where it is located.

Based on the MSME classification used in the Philippines, those with 10-99 employees are categorized as small business. On the other hand, businesses employing 1-9 are in the "micro business" category while firms with 100-199 employees are considered medium sized businesses.

The results indicate that the businesses operating under the OTOP program in the province of Tarlac are generally on a micro and small scale. This is consistent with the findings in several researches about businesses in the country which state that majority of them belong to micro and small businesses. Worth mentioning is the DTI 2013 report provided by the Philippine Statistics Authority (PSA). Of the 941,174 establishments in the Philippines, 99.6% (937,327) are micro, small, and medium enterprises (MSMEs) and the remaining 0.4% (3,847) are large enterprises. Of the total number of MSMEs, 90.3% (846,817) are micro enterprises, 9.3% (86,762) are small

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enterprises, and 0.4% (3,748) is medium enterprises.

Interestingly, these small businesses fuel the economy of our country. Their growing number makes them an indispensable part of the economic life of our nation. They are the engines of growth and progress in the cities and countryside. They make use of the local resources and talents, helping alleviate their economic statuses.

1.2.Average Sales for the Past Three Years

Table 2 illustrates the average sales of the 30 firms for the past three (3) years.

Table 2
Average Sales for the Past 3 Years
N=30

Average Sales for the Past 3 Years	F	%
PhP5,000,000.00 or less	25	83.34
PhP5,000,001.00-PhP10,000,000.00	2	6.67
PhP10,000,001.00-PhP15,000,000.00	1	3.33
PhP15,000,001.00-PhP20,000,000.00	1	3.33
PhP35,000,001.00-PhP40,000,000.00	1	3.33
Total	**30**	**100**

Majority of the businesses surveyed, that is 25 out of 30, were earning revenues of PhP 5,000,000.00 or less. Of the 25 businesses, 17 of them have average revenues of less than a million pesos a year. These were the micro businesses involved in sugarcane products, wine, meat business, food processing, delicacies, crochet, and handicrafts. On the other hand, there were two (2) which generated sales between PhP5,000,001.00 to PhP10,000,000.00. They were involved in native cakes and large scale and commercialized meat-processing business. The rest have the power to sell products amounting to PhP10,000,000 up to PhP40,000,000.00. These were the businesses that export local vegetables and restaurant business.

Judging from the findings, the bulk of the OTOP businesses do not have that earning power yet because they belong to the micro and small businesses. But many of them consider their sales to be satisfactory. Even though they have small earnings, they still manage to sustain their operations and be of help to the local economy, contributing to the tax revenues and employing people. They also promote local products and effectively utilize the skills of the people in the communities where they belong.

1.3.Amount of Investment

Table 3 shows the investment scenario of the OTOP business-beneficiaries.

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Table 3

Amount of Investment

N=30

Amount of Investment	F	%
PhP5,000,000.00 or less	28	93.34
PhP5,000,001.00-PhP10,000,000	1	3.33
PhP15,000,001.00-PhP20,000,000.00	1	3.33
Total	**30**	**100**

The data reveals that majority, that is 28 of the firms surveyed, have invested PhP5,000,000.00 or less in the recent years. Of the 28, eight (8) of them have millions worth of investment, with the rest in hundreds and tens of thousands of pesos. There were two (2) which became bigger by more than PhP5,000,000.00 up to PhP20,000,000.00.

From the data discussed, the firms under the OTOP program in the province of Tarlac have modest to considerable amount of investment in the recent years, which is true for many micro, small and medium scale businesses nowadays. The entrepreneurs seemed to have learned the power of investment to their businesses so they started pouring in money to increase their inventories and make them more equipped in providing satisfaction to their customers.

2. Key Success Factors

2.1.Entrepreneur

Table 4 presents the entrepreneur-related key success factors and how the entrepreneurs described their importance in the achievement of success. The average ratings were described using the verbal descriptions.

Table 4

Entrepreneur

Entrepreneur Related Key Success Factors	Mean	Verbal Descriptions
Good Management Skills	4.60	Extremely important
Charisma, Friendliness	4.53	Extremely important
Previous Working Experience	4.17	Very important
Hardwork	4.83	Extremely important
Ability to Manage Personnel	4.40	Very important
Social Skills	4.17	Very important
Reputation for Honesty	4.77	Extremely important
Key Success Factor Entrepreneur	**4.50**	**Extremely important**

There were seven (7) key success factors related to entrepreneur: good management skills, charisma or friendliness, previous work experience, hard work, ability to manage personnel, social skills, and reputation for honesty. These factors were

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combined to give the entrepreneur key success factor of the respondents a mean equivalent of 4.50, which is extremely important according to the importance scale. This means that the entrepreneur is a key to business success. Highly associated with the said key success factor is the application of managerial skills, exercise of interpersonal skills with the clients, and giving much time and effort to make the business flourish. And also related is the practice of honesty in all the dealings with the clients, suppliers, and other stakeholders.

The respondents gave due consideration to the specific entrepreneur-related key success factors. The factors were either extremely important or very important. Those that were extremely important were good management skills (4.60), charisma or friendliness (4.53), hard work (4.83) and reputation for honesty (4.77). Meanwhile, previous working experience (4.17), ability to manage personnel (4.40), and social skills (4.17) were considered to be very important to the OTOP entrepreneur-beneficiaries. These findings corroborated some results generated by the researches of Zimmerman and Chu (2013), Bouazza et. al. (2015), and Stefanovic et. al (2010) that good general management, management capacities, interpersonal skills, and leadership skills are success factors in business.

From the findings, the entrepreneur-beneficiaries of the OTOP program in Tarlac were very particular with the skills that will make their business work and were also concerned with the way they deal with the customers. They prefer to be cordial and appealing to attract customers to buy their products. They spend enough time, give their full effort and do the extra mile in their businesses simply because these are their bread and butter. Also, in whatever they do, they try to be fair and truthful to all in terms of the products and services they offer. They believe that they will never go wrong with honesty.

Furthermore, they place great importance to what they have learned from the past, particularly in business, and they include that in their arsenal of business weapons to be able to operate successfully. They put premium when it comes to managing their people because they believe that effectively managed personnel can serve as ambassadors of goodwill for the business. This is also their way of exercising social responsibility. The entrepreneur-beneficiaries likewise put emphasis on effective interaction and communication with the clients and other stakeholders as a way of creating better understanding, leading to more business transactions, which will definitely benefit the businessman.

2.2.Enterprise

Table 5 shows the key success factors related to the enterprise and how the

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entrepreneurs define their significance to their businesses.

Table 5

Enterprise

Enterprise Related Key Success Factors	Mean	Verbal Descriptions
Appropriate Training	4.33	Very important
Marketing/Sales Promotion	4.67	Extremely important
Good Product at Competitive Price	4.67	Extremely important
Good Customer Service	4.70	Extremely important
Maintenance of Accurate Records	4.43	Very important
Key Success Factor Enterprise	**4.56**	**Extremely important**

Enterprise related key success factors consisted of operational systems and strategies, and market offerings: appropriate training, marketing/sales promotion, good product at competitive price, good customer service and maintenance of good records. All of these are essential tools for the business to have smooth and productive operations and to effectively deal with the customers.

From the data presented, the overall rating for the enterprise related key success factor is 4.56, which suggests extreme importance to the respondents. Like what was stated earlier, the success factors related to the enterprise are essential tools for the business to have smooth and productive operations and to make it more responsive to the needs of the customers. The employees can function productively when they are provided with the necessary training. Products can be disposed if they are good enough for the customers, priced reasonably, or marketed using proven marketing and sales promotion strategies. Customers will likewise make a repeat purchase because of these, aside from the quality service given to them by the business. And the business can have an effective financial management if there is a good record keeping. All of these are what make enterprise related key success factors indispensable tools for the respondents.

The data shows that good customer service (4.70), marketing/sales promotion and good product at competitive price (both 4.67) were extremely important to the respondents. On the other hand, appropriate training (4.33) and maintenance of accurate records (4.43) were considered to be very important to the entrepreneurs. The data again partially supported the findings of the studies of Zimmerman and Chu (2013), Bouazza et. al. (2015), and Stefanovic et. al. (2010) that appropriate training, accurate record keeping, marketing, and competitive product and service are indispensable to entrepreneurial success.

From the results of the survey, it can be deduced that the entrepreneur-beneficiaries of the OTOP Program greatly consider not just business and personnel development strategies, but good products as well to compete well with other

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businesses. The strategies were in line with the needs of the employees to provide customers the service they deserve and consistent with the basic idea in marketing, that is, the creation of products that are truly needed by the people. One of the strategies also adheres to the requirement in marketing that products must be communicated and promoted to gain attention from the customers, which may lead to purchase.

Moreover, the respondents seem to value the importance of monitoring the progress of their business through the regular maintenance of accurate records. They are very interested in their sales and expenses and use these records to determine whether their business is doing well or not. The respondents were very well aware of the basics of financial management and that is the religious record keeping of all the cash inflows and outflows to monitor the flow of cash and make an informed decision when it comes to finances.

2.3. Network

Table 6 is an illustration of the importance given by the respondents to the network-related key success factors.

Table 6

Network

Network Related Key Success Factors	Mean	Verbal Descriptions
Support of Family and Friends	4.40	Very important
Position in the Society	2.83	Mildly important
Key Success Factor Network	**3.62**	**Very important**

In this research, the network-related key success factor is comprised of the support of family and friends and position in the society. Family members and friends may serve as weapons in creating a much larger network that can help the entrepreneur promote or finance the business. Likewise, a position in the society may give the businessman the opportunity to meet other people who can possibly serve the same purpose as the family members and friends.

The data presented on the table illustrates the significance of network-related key success factors to the entrepreneur-beneficiaries. The overall mean was 3.62, which indicates that network, in general, is very important to the respondents.

Exploring deeply into the network-related key success factors, the entrepreneurs consider their family and friends as stronger allies in their network. With a mean of 4.40, these people are considered to be very important for them. However, position in the society, with a mean of 2.83, is not regarded well by the respondents in the creation of their so-called “network”. Thus, it is deemed mildly important for them. The level of importance given is not that high, but it is still deemed as an important factor to business success. The perception of significance of societal position as a success factor

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coincides with the finding in the study of Stefanovic et. al. (2010).

Judging on the findings, the respondents still prefer their family and friends as the "movers" in their network. The entrepreneurs wanted to have a close business network related by blood and years of association and friendship. The preference given to family members is understandable since Filipinos are known to be very close with their family. In the Philippines, it is common to have extended families in residential compounds where close relatives live next to each other. Family members are trusted allies of the Filipino entrepreneur. The same preference is also given to friends. Local businessmen want their friends to be closer to them. This is because Filipinos are friendly people. They believe in what their friends can do for them. This belief extends in business. It is also a known fact that Filipino entrepreneurs rely on their friends to promote or finance their business. When a business is in the introduction period, friends are usually the first ones being invited to try the products they offer. And these people undoubtedly do their share of helping their entrepreneur friend further grow the business.

The respondents, in building their network, seldom use position in the society. It is because few of them were not lucky enough to be given some distinction or position in the society where they belong. For those who have the position, they take advantage of it but for many of the respondents, the readily available allies of family members and friends are still favored to comprise their business network.

2.4. Business Environment

Table 7 shows the respondents' perceived importance on the key success factors connected with business environment.

Table 7

Business Environment

Business Environment Key Success Factor	Mean	Verbal Descriptions
Satisfactory Government Support	4.27	Very important
Access to Capital	4.40	Very important
Political Involvement	1.57	Not very important
Key Success Factor Business Environment	**3.41**	**Mildly important**

As shown in the table, the key success factors on the business environment centered on the government support, access to capital, and political involvement. These forces provide the things necessary for the business to further achieve growth and success. Government assistance projects may help improve the skills of the entrepreneur and the employees, the business system or procedures, or even its products and the way of dealing with the customers. Additional capital can make it possible for the business in procuring more inventories, machines and other inputs. Political involvement may

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create sound business environment for the entrepreneurs.

The overall mean for the business environment key success factor was 3.41; clearly showing that it is mildly important for the entrepreneur respondents in the study.

Digging deeper into the specific key success factors, two (2) were considered very important by the respondents: satisfactory government support (4.27) and access to capital (4.40). Political involvement (1.57) is not very important to the respondents. But it still has a little importance to the entrepreneur-respondents. These data are consistent with the results in the studies of Zimmerman and Chu (2015) and Bouazza et. al (2015) claiming that political association and access to external financing are connected to firm's success.

From the results, we can construe that the beneficiaries of the OTOP program in the province are very open when it comes to government support and access to capital. They regarded these as a big boost to their entrepreneurial undertaking, supporting their claims to these factors as "very important" to their success. Many Filipino entrepreneurs are not that armed when it comes to business so whatever assistance being offered to them are greatly embraced. A case in point is the OTOP program in the province, which has offered a lot to the entrepreneur respondents when it comes to developing their entrepreneurial skills, their systems, techniques, products, and even the technology when it comes to production and manufacturing. The OTOP program was considered by many beneficiaries to have further led their business to success. Many opportunities were opened because of their involvement and cooperation with the OTOP program and brought them to new business horizons. Another resource that is lacking among small businesses in the country is capital. Some of the entrepreneur respondents, however, were lucky enough to have accessed some sources of financing which have led them to expanding their businesses.

The entrepreneur respondents were seldom involved in politics or do not see politics affecting their business that much which is why they believe that political involvement is not that very important to business success. Many Filipino businessmen distrust the institution of politics with all of its complexities and pressures. They try to move away from it as much as possible and concentrate more on the things that will surely give them a bigger chance of success in their businesses.

3. Entrepreneurial Orientations

3.1. Innovativeness

Table 8 depicts the degree of innovativeness of the entrepreneur-beneficiaries of the OTOP program in the province of Tarlac.

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Table 8

Innovativeness

Innovativeness	Mean	Verbal Descriptions
Emphasis on R&D, technological leadership, and innovations	5.10	High
Very many new lines of products or services are offered	3.47	Moderate
Dramatic changes in the product or service lines	4.83	High
Innovativeness Entrepreneurial Orientation Mean	**4.47**	**Moderate**

As seen on the table, the average rating for innovativeness among the 30 respondents is 4.47, which means that the subjects are on the middle side of innovativeness based on the 5-point scale used in describing the entrepreneurial orientations. Significant efforts were initiated on product improvements. But the entrepreneurs are offering less product lines compared to their counterparts from the other provinces. Among them are the entrepreneurs selling okra, handicrafts, chicharon, and tinapa.

More specifically, the entrepreneurs have high emphasis on the use of latest product research, technologies, and innovative strategies with an average rating of 5.10. When it comes to the number of product offerings, the mean rating of 3.47 signals that the respondents do not have very good performance on that aspect of innovativeness. This is because they have no additional products for the past five (5) years. On the aspect of product changes or improvements, the average rating of 4.83 signifies that the beneficiaries are strongly inclined with that strategy. The entrepreneur who produces chichacorn, for example, produces products, that is different from that in Ilocos because it is whiter and crispier. In Paniqui, water lilly based products are produced with more enhancements in the design, and a restaurant in Tarlac City produces cakes and pastries with a significant twist, which is a big deal for the customers.

Interpreting the findings, innovativeness cannot be strongly counted as a focus or direction of the beneficiaries of the OTOP program in the province of Tarlac. Although there are signs in the products of some entrepreneurs, generally speaking, they are not yet that innovative. In relation to product improvement and product changes, they are showing signs that they are on that track. The same is true on the use of latest product research, technologies, and innovations. The respondents need to learn more about the art and benefits of product innovation so they could compete more successfully with the other OTOP products in the country.

3.2. Proactiveness

Table 9 presents how proactive the entrepreneur-beneficiaries are in their business

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operations.

Table 9

Proactiveness

Proactiveness	Mean	Verbal Descriptions
Initiates actions responded to by competitors	5	High
First to introduce new products/services, administrative techniques, and operating technologies	5.07	High
Adopts a very competitive, "undo the competitors" posture	4.33	Moderate
Proactiveness Entrepreneurial Orientation Mean	**4.80**	**High**

The average rating of the entrepreneurs on proactiveness is 4.80, which is in the bracket of 4.60-5.79 on the EO (entrepreneurial orientation) scale. This means that the entrepreneur-respondents have a high sense of proactiveness or reactiveness.

Looking at the specific parameters of being proactive, the respondents have high tendency to initiate actions worth emulating by other businessmen (5), and also with the strong inclination to first introduce new products, techniques and technologies in the market (5.07). In terms of competitiveness, the respondents adopt the neutral side (4.33).

There are realizations in the findings. The entrepreneur respondents are forward looking. They make things happen. They know the benefits of being the first in starting fresh moves and actions in the industry, and in pioneering new products, techniques, and technologies. Businesses can capitalize on these strategies, and can even use them to their advantage. The entrepreneurs, however, have their soft side when it comes to their competitors. They are not the type of players in the so-called "Red Ocean Strategy" where there is intense competition among the business firms and entrepreneurs. As such, there is friendly competition. The respondents seem to value their co-existence with their competitors. From the interviews conducted, there were those who said that they were happy seeing their competitors doing well in their business and providing the needs of their families.

3.3. Risk Taking

The entrepreneur-beneficiaries' manners of taking risk are shown in Table 10.

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Table 10

Risk Taking

Risk Taking	Mean	Verbal Descriptions
A strong proclivity for high risk projects with high returns	4.67	High
Bold ranging acts are explored owing to the nature of the environment	5	High
Adopts a bold, aggressive posture to maximize probability of exploiting potential opportunities	5.03	High
Risk Taking Entrepreneurial Orientation Mean	**4.90**	**High**

As can be gleaned from the table, the overall risk taking rating of the 30 respondents is 4.90, which is described as high on the entrepreneurial orientation scale. On the particular indicators, the entrepreneur-beneficiaries, just like the overall description for proactiveness, have a leaning towards being a high risk taker: attraction or predilection to high risk projects is 4.67, adoption of bold, wide ranging acts is 5, and implementation of aggressive moves for opportunities is 5.03.

Similar status on the state of responsiveness previously discussed can be extended in risk taking among the 30 entrepreneur-respondents. The entrepreneur-beneficiaries of the OTOP program, in broad spectrum, like to take chances. They are bold in their strategies. Several circumstances still prevent many entrepreneurs from being converted into this kind of status, but obviously for the respondents, they seem to know the idea that the greater the risk one has entered into, the greater the possible rewards that can be possibly reaped in the future. The entrepreneur respondents welcome risky business opportunities and explore them with a wide range of strategies. They will do whatever they can to fully exploit some breaks in business. No stones will be left unturned in matters of business opportunities.

This conclusion agrees with the findings about Filipino entrepreneurs. In literatures, local entrepreneurs are either risk averse, risk takers, or calculated risk takers. Many Filipino entrepreneurs are largely calculated risk takers, making sense of the risks they encounter, and evaluating them whether they are reasonable for the business or not. But the respondents in this research belong to the other breed of entrepreneurs on risk taking. They are way above the common Filipino businessmen.

3.4. Competitive Aggressiveness

Table 11 is a depiction of the competitive aggressiveness EO of the 30 beneficiaries of the OTOP program in Tarlac.

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Table 11

Competitive Aggressiveness

Competitive Aggressiveness	Mean	Verbal Descriptions
Strong tendency to be ahead of the competitors in introducing novel products or ideas	4.33	Moderate
My firm is very aggressive and intensely competitive	4.43	Moderate
Competitive Aggressiveness Entrepreneurial Orientation Mean	**4.38**	**Moderate**

The mean rating for the competitive aggressiveness of the 30 entrepreneur-respondents is 4.38. This signifies that the entrepreneurs' competitive aggressiveness is on the neutral side based on the EO scale average rating bracket.

On the specific parameters of competitive aggressiveness, the respondents tend to stay in the middle of the game. The average rating on the aspect of race against competitors in introducing novel ideas or products was 4.33, while in the degree of firm aggressiveness and competitiveness, the mean rating was 4.43.

The results support the conclusion that the entrepreneur-beneficiaries are on the safe side when it comes to competitive aggressiveness. They do not take chances at competition and seem to maintain the status quo. They are not interested at the possible reward when competing with others became successful. Also, they do not want the complications and pressures of competing and seem to like the harmonious co-existence with other competitors. They seem to be happy seeing their competitors still operating in the market.

From the interviews among the respondents, what matters most to them is they survive the daily living requirements. They do not aim for very high sales and profits. Reasonable profit is enough for them. They would be happy seeing their competitors making money everyday and provide also for their families

3.5. Autonomy

Table 12 presents the autonomy inside the firms managed by the 30 entrepreneur-beneficiaries.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 12

Autonomy

Autonomy	Mean	Verbal Descriptions
Managers guide the work of teams or individuals	4.83	High
The manager provides the primary impetus for pursuing business opportunities	5.53	High
Supervisory approval is sought by individuals/employees for pursuing business opportunities	5.73	High
The manager plays a major role in identifying and selecting entrepreneurial opportunities.	5.77	High
Autonomy Entrepreneurial Orientation Mean	**5.47**	**High**

The table shows that the average rating for the autonomy EO is 5.47. This figure leans towards the situation where the manager is the powerful person on matters of work guidance, and decision-making on business opportunities.

The average ratings for the parameters under the autonomy EO support overall rating for the autonomy EO. Work guidance is implemented at a high level (4.83). There is a strong inclination towards the strategy where the manager is the initiator of business opportunities (5.53). Also, supervisor approval is highly required when individuals or teams decide on business breaks (5.73), and the manager plays a major role in identifying and selecting the prospects the business pursues (5.77).

Based on the findings, the entrepreneur-beneficiaries are not advocates of autonomy or freedom at work or in making decisions. This is not because the entrepreneurs do not trust their employees, but because they prefer to take matters into their own hands. They are still more knowledgeable on what business opportunities to pursue and explore and that is why they are the final decision makers.

The respondents also want to make sure that all things are going smoothly inside the organization, thus, regular supervision and guidance is necessary. Moreover, the entrepreneurs want to ensure that the outputs, whether that is work or products, are of the best quality. This is one way of maintaining the good reputation of their business.

4. Relationship of the Performance Variables with the Key Success Factors and Entrepreneurial Orientation

4.1.1. Relationship of Employment Generation to Key Success Factors

Table 13 shows the relationship of employment generation to the key success factors of the entrepreneur respondents.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 13

Relationship of Employment Generation to Key Success Factors

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Employment generation x Entrepreneur	.4349	Significant
Employment generation x Enterprise	.3774	Significant
Employment generation x Network	.1460	Not Significant
Employment generation x Business Environment	.4599	Highly significant
Critical values at two tail test .349 at 5% level .449 at 1% level		

As seen from the data presented, more important among the key success factors with significance in employment generation is business environment (r=.4599). This means that a very good business environment will create a situation where a business firm will hire more employees. Other factors such as entrepreneur (r=.4349) and enterprise (r=.3774) also have positive relation on employment generation. Network has no relation or significance.

How the business environment factors affect employment is depicted in Table 14.

Table 14

Relationship of Business Environment Related Key Success Factors to Employment Generation

BUSINESS ENVIRONMENT RELATED KEY SUCCESS FACTORS	COEFFICIENT OF CORRELATION, r
	Employment Generation
Satisfactory Government Support	0.5758**
Access to Capital	0.5934**
Political Involvement	0.2117ns
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

Satisfactory government support like One Town, One Product (OTOP) project, promotions, networking and others, as well as making funds available for micro, small and medium sized businesses can contribute to growth, thus making it imperative to employ more people. The OTOP project of the government, alone, has been instrumental in the increase in the network and expansion of the market of local enterprises. The need to sustain the demand for their products brought them to use the

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

strategy of hiring more employees. Additional capital also enabled the entrepreneurs to purchase more raw materials and machines, and has also provided the leverage to engage more employees working for them to further sustain their operations and be of service to the community by providing more products to the people.

Table 15 illustrates how the entrepreneur related key success factors relate to employment generation.

Table 15

Relationship of Entrepreneur Related Key Success Factors to Employment Generation

ENTREPRENEUR RELATED KEY SUCCESS FACTORS	COEFFICIENT OF CORRELATION, r
	Employment Generation
Good Management Skills	0.4445*
Charisma, Friendliness	0.4377*
Previous Working Experience	0.4030*
Hard Work	0.4667**
Ability to Manage Personnel	0.4252*
Social Skills	0.4030*
Reputation for Honesty	0.4609**
Critical values at two tail test .349 at 5% level, .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

There were two (2) highly significant entrepreneur related key success factors related to employment: reputation for honesty (r=0.4609) and hard work (r=0.4667). The more the entrepreneur is being honest with regard to the human resource needs of the firm and the higher the value for hard work is, the more employees will be hired for the business. Meanwhile, good management skills, charisma, previous working experience, ability to manage personnel, and social skills all have positive connections to employment generation.

Table 16 shows the connection of the enterprise related key success factors to the generation of employment.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 16
Relationship of Enterprise Related Key Success Factors to Employment Generation

ENTERPRISE RELATED KEY SUCCESS FACTORS	COEFFICIENT OF CORRELATION, r
	Employment Generation
Appropriate Training	0.3583*
Marketing/Sales Promotion	0.3865*
Good Product at Competitive Price	0.3865*
Good Customer Service	0.3889*
Maintenance of Accurate Records	0.3666*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

It is clearly illustrated in the table that all the enterprise related key success factors have significant effects to employment, and good customer service has the highest coefficient of correlation among them. Human resource is definitely necessary in providing satisfactory customer service. Proper training in business management, including managing people, stresses the importance of employees in business operations. Creating and promoting products also necessitate people to be more effective. The management of business records will be more efficient when the business has the right number of staff.

The findings support the conclusion that business environment, entrepreneur, and enterprise provide positive direction to employment generation among the firms managed by the entrepreneur-beneficiaries. The power of government assistance and capital, the knowledge and skills of the entrepreneur, and the systems and offerings of the enterprise are precursors of growth in business that can be maintained by employing more people. Employment generation has been a serious problem in the country, with many people having a hard time being deployed in jobs that suit them. Based on the conclusion, the power of the entrepreneur, enterprise, and business environment as key success factors must be capitalized to help solve this big issue in the country.

4.1.2. Relationship of Average Sales to Key Success Factors

Table 17 shows the relationship of average sales to the key success factors: entrepreneur, enterprise, network, and business environment.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 17

Relationship of Average Sales to Key Success Factors

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Average sales x Entrepreneur	.018	Not significant
Average sales x Enterprise	.382	Significant
Average sales x Network	-.132	Not significant
Average sales x Business Environment	-.061	Not significant
Critical values at two tail test .349 at 5% level .449 at 1% level		

From the data, all of the key success factors do not affect the average sales of the firms managed by the entrepreneur-beneficiaries, except for the enterprise (r=.382) key success factor. The enterprise has positive relationship with sales and that means that effectively managed business will generate more revenues. This is the case of the micro, small, and medium enterprises subjected in this study. They have survived the many years of their existence because they have the arsenal of business tools needed to respond to the circumstances.

The specific enterprise related key success factors with a direct relation to sales generation are presented in Table 18.

Table 18

Relationship of Enterprise Related Key Success Factors to Average Sales

ENTERPRISE RELATED KEY SUCCESS FACTORS	COEFFICIENT OF CORRELATION, r
	Average Sales
Appropriate Training	0.3627*
Marketing/Sales Promotion	0.3912*
Good Product at Competitive Price	0.3912*
Good Customer Service	0.3937*
Maintenance of Accurate Records	0.3711*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The specific success factors of appropriate training for the employees, marketing/promotion, good product at competitive price, good customer service, and maintenance of accurate records associated with the enterprise key success factor can be

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

correlated with average sales. The sales generated by the firms managed by the entrepreneur-beneficiaries depend on these factors. The purchase of product actually starts from a good product with a reasonable price. Customers can't resist a good product, more so if it is even more practical to buy it because of its low price and benefits. The product will also go a long way when it is properly marketed and promoted by someone with exceptional customer service. A product, with all its benefits, must be properly communicated to the customers in order for them to appreciate it. And customers tend to have a repeat purchase when served by people with the right skills and attitude towards them. Good record keeping can also provide a clear picture of cost and expenses, thus providing a more reasonable pricing for products that can encourage purchase among customers, which translate into sales for the business.

Deciphering the data, it is right to say that the enterprise key success factor, featuring the elements of good product, promotion, and customer service, is a driver of sales among the small and medium enterprises in the OTOP program in the province of Tarlac.

4.1.3. Relationship of Investment to Key Success Factors

Table 19 shows the kinds of relationship investment have on the key success factors.

Table 19

Relationship of Investment to Key Success Factors

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Investment x Entrepreneur	-.047	Not significant
Investment x Enterprise	-.066	Not significant
Investment x Network	-.423	Significant
Investment x Business Environment	-.149	Not Significant
Critical values at two tail test .349 at 5% level .449 at 1% level		

Only one (1) key success factor has significant relationship with investment and that is the network. And surprisingly, it has negative effect on investment. That means, as the entrepreneur expands the network, the less is the support when it comes to funding. In the Philippines, there are cases where the people close to a person are also the same people who are difficult to borrow money from for business. The closeness of the entrepreneur to friends and family members makes it easy to forget the money borrowed for business. And this is where the latter have learned their lessons. But they can also lend their support in other aspects, like promoting the products through word of mouth, thus also helping the businessman in return.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 20 shows the association of network to investment.

Table 20

Relationship of Network Related Key Success Factors to Investment

NETWORK RELATED KEY SUCCESS FACTORS	COEFFICIENT OF CORRELATION, r
	Investment
Support of family and friends	-0.5141**
Position in the society	-0.3306ns
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The data from the table stresses the significant but highly negative relationship of friends and family members to investment. Meanwhile, position in the society has no effect on investment.

Judging from the data, none among the key success factors can cause a positive direction for the investment as performance variable.

4.2.1. Relationship of Employment Generation to Entrepreneurial Orientation

Table 21 depicts the correlation of employment generation to the entrepreneurial orientations: innovativeness, proactiveness or reactiveness, risk taking, competitive aggressiveness, and autonomy. Their effects on hiring employees were determined.

Table 21

Relationship of Employment Generation to Entrepreneurial Orientations

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Employment generation x Innovativeness	.364	Significant
Employment generation x Proactiveness	-.034	Not significant
Employment generation x Risk Taking	.3748	Significant
Employment generation x Competitive aggressiveness	-.0519	Not significant
Employment generation x Autonomy	.022	Not significant
Critical values at two tail test .349 at 5% level .449 at 1% level		

There are two (2) entrepreneurial orientations that have a positive effect on employment generation: innovativeness (r=.364) and risk taking (r=.3748). Responsiveness, competitive aggressiveness, and autonomy were discovered to have no connection with the said performance variable.

Table 22 provides the specific innovativeness factors with relation to employment generation.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 22

Relationship of Innovativeness to Employment Generation

INNOVATIVENESS	COEFFICIENT OF CORRELATION, r
	Employment Generation
Emphasis on R&D, technological leadership, and innovations	0.4153*
Very many new lines of products or services are offered	0.2825ns
Dramatic changes in the product or service lines	0.3933*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The practice of innovativeness has positive correlation with employment generation. Looking at the parameters for innovativeness on Table 24, the emphasis on research and development and use of technology and innovations has significant effects on the number of employees hired. The employment of this strategy means additional people for the business. The same is true when there are breakthroughs in the products or services made by the enterprise. Products and processes have to be changed, improved, and adjusted, and that makes it labor intensive. It necessitates products to be much different from what was earlier offered in the market. They are either more embellished, tastier, more appealing, or responds better to customer needs. And those demands can be delivered if the entrepreneur has more manpower to do the other work required to create better products for the market. Thus, the more innovative the entrepreneur is, the greater is the need for workers.

Table 23 shows the connection of risk taking to employment generation.

Table 23

Relationship of Risk Taking to Employment Generation

RISK TAKING	COEFFICIENT OF CORRELATION, r
	Employment Generation
A strong proclivity for high risk projects with high returns	0.3572*
Bold ranging acts are explored owing to the nature of the environment	0.3824*
Adopts a bold, aggressive posture to maximize probability of exploiting potential opportunities	0.3847*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

Another entrepreneurial orientation with direct effect on employment generation

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

is risk taking. Based on the table, all of the parameters are significantly related, indicating close connection to employment creation. The penchant to explore high-risk projects or decisions to explore bold wide-ranging actions to help achieve the firm's objectives requires the hiring of people. It can be considered as a risky undertaking because sometimes, an entrepreneur is not sure about the consistency in the work attitude and ethics of the people hired. At first, they present their good side but afterwards, they may lessen their productivity or lose their motivation. Further, hiring many people may be good for the business firm but there might be situations where they would possibly turn into liabilities. These are some reasons why hiring people sometimes could be very detrimental for the firm. But because the entrepreneur has the tolerance for risk, hiring more people can also be considered as an aggressive move to make the business move forward.

The findings indicate that the entrepreneur's desire to make better products and his tolerance for risks creates a situation where employees are highly welcome to enter the business firm.

4.2.2. Relationship of Average Sales to Entrepreneurial Orientations

The correlations of average sales and entrepreneurial orientations of the entrepreneur-beneficiaries are illustrated in Table 24.

Table 24

Relationship of Average Sales to Entrepreneurial Orientations

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Average sales x Innovativeness	-.452	Highly significant
Average sales x Proactiveness	.443	Significant
Average sales x Risk taking	.531	Highly significant
Average sales x Competitive Aggressiveness	.376	Significant
Average sales x Autonomy	.019	Not significant
Critical values at two tail test =.349 at 5% level, .449 at 1% level		

There are two (2) entrepreneurial orientations with highly significant effects on average sales: innovativeness (-.452) and risk taking (r=.531). However, innovativeness has negative effect on sales, which means high innovativeness translates to lower sales. Proactiveness (r=.443) and competitive aggressiveness (r=.376), on the other hand, have significant effects. These findings imply that being responsive and competitively aggressive can help the entrepreneur generate revenues for the business. Meanwhile, autonomy has no significance to the performance variable.

Table 25 summarizes the relationship of innovativeness to average sales.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 25

Relationship of Innovativeness to Average Sales

INNOVATIVENESS	COEFFICIENT OF CORRELATION, r
	Average Sales
Emphasis on R&D, technological leadership, and innovations	-0.5157**
Very many new lines of products or services are offered	-0.3508*
Dramatic changes in the product or service lines	-0.4884**
Critical values at two tail test=.349 at 5% level, .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The effort to improve products can really have a higher effect on sales but on a negative side. This implies that the more innovative the product is, the lower its sales would be.

All of the parameters pertaining to innovation have negative relationship to average sales, which seem to be unlikely, but upon closer consideration, over innovation in a product can sometimes make it unwanted because of the learning curve involved. Products are purchased based on their fitness for use. This is true to senior citizens and people who do not want complicated things. And such products also tend to be more expensive than others. As such, the demand is low thereby affecting sales.

The relationships of the particular parameters of risk taking to average sales are recapped in Table 26.

Table 26

Relationship of Risk Taking to Average Sales

RISK TAKING	COEFFICIENT OF CORRELATION, r
	Average Sales
A strong proclivity for high risk projects with high returns	0.5060**
Bold ranging acts are explored owing to the nature of the environment	0.5418**
Adopts a bold, aggressive posture to maximize probability of exploiting potential opportunities	0.5450**
Critical values at two tail test=.349 at 5% level, .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The risk taking EO also has a bold effect on sales. An entrepreneur who is considered a risk taker is fond of exploring some opportunities, which are less rosy for some, but seen to give positive returns, including increase in sales. This is proven in the highly significant relationships of the risk taking parameters to average sales as shown in the previous table.

Table 27 explores the relationship of proactiveness to average sales

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 27

Relationship of Proactiveness to Average Sales

PROACTIVENESS	COEFFICIENT OF CORRELATION, r
	Average Sales
Initiates actions responded to by competitors	0.4614**
First to introduce new products/services, administrative techniques, and operating technologies	0.4679**
Adopts a very competitive, "undo the competitors" posture	0.3996*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

In the case of proactiveness, the positive relationship among the specific variables to sales is understandable since a pioneering work or effort will make a mark on the customers. A first mover in making some actions and in introducing new products, techniques and technologies has its own set of advantages and positive results on sales.

Table 28 shows the relationship of competitive aggressiveness to average sales.

Table 28

Relationship of Competitive Aggressiveness to Average Sales

COMPETITIVE AGGRESSIVENESS	COEFFICIENT OF CORRELATION, r
	Average Sales
Strong tendency to be ahead of the competitors in introducing novel products or ideas	0.371*
My firm is very aggressive and intensely competitive	0.380*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

On the side of competitive aggressiveness, an entrepreneur who will tend to be intensely competitive, coming up with some strategies that will win the customers, will produce revenues for the business. The desire to be ahead in rolling out new products will also have the same result for the company.

Unfortunately, in the case of the respondents, autonomy has no correlation with average sales.

From the results, one can't help but think that being responsive, bold, and competitive will certainly move mountains for the entrepreneur, especially in the case of sales. If the entrepreneur wants to generate a lot of money, then he must learn how to have the aforementioned qualities.

4.2.3. Relationship of Investment to Entrepreneurial Orientations

Findings on the correlation between investment and the entrepreneurial orientations

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

are presented in Table 29.

Table 29

Relationship of Investment to Entrepreneurial Orientations

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Investment x Innovativeness	-.411	Significant
Investment x Proactiveness	.391	Significant
Investment x Risk taking	.529	Highly significant
Investment x Competitive aggressiveness	.381	Significant
Investment x Autonomy	-.028	Not Significant
Critical values at two tail test=.349 at 5% level, .449 at 1% level		

A notable finding in this case is the high significance of risk taking (r=.529) to investment. On the other hand, being proactive (r=.391), and competitively aggressive (r=.381) have significant relationship to investment. This implies that the presence of these qualities on the entrepreneur may well have a say on the money that is invested in the business. Innovativeness has a negative effect on investment while autonomy has no relation at all.

Table 30 provides a summary of the connection of risk taking parameters to investment.

Table 30

Relationship of Risk Taking to Investment

RISK TAKING	COEFFICIENT OF CORRELATION, r
	Investment
A strong proclivity for high risk projects with high returns	0.5041**
Bold ranging acts are explored owing to the nature of the environment	0.5397**
Adopts a bold, aggressive posture to maximize probability of exploiting potential opportunities	0.5430**
Critical values at two tail test=.349 at 5% level, .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

All the parameters have high significance to investment. This denotes that if a person is a risk taker, the higher is the amount of money that will be invested in the firm. A risk taker does whatever it takes to make the business prosper, including the channeling of funds to the business in order to make the necessary purchases and to be able to implement some strategies.

Table 31 illustrates the relationship of proactiveness to investment.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 31

Relationship of Proactiveness to Investment

PROACTIVENESS	COEFFICIENT OF CORRELATION, r
	Investment
Initiates actions responded to by competitors	0.4072*
First to introduce new products/services, administrative techniques, and operating technologies	0.4129*
Adopts a very competitive, "undo the competitors" posture	0.3527*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The factors related to proactiveness have significance to investment. That means being reactive to situation entails the spending of money. Being proactive requires the constant thinking and implementation of strategies to be ahead of the game and this also needs money. To many people, advertising a new product is a simple strategy but it involves many hours of researching and planning. That alone is already a big investment. The cost of developing a novel product is a different case, as well as the adoption of new systems or techniques, or the latest technologies. These strategies also require the budget office to release funds for the effective implementation.

Table 32 lists the parameters on competitive aggressiveness and their relationship to investment.

Table 32

Relationship of Competitive Aggressiveness to Investment

COMPETITIVE AGGRESSIVENESS	COEFFICIENT OF CORRELATION, r
	Investment
Strong tendency to be ahead of the competitors in introducing novel products or ideas	0.3766*
My firm is very aggressive and intensely competitive	0.3853*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The specific measures for competitive aggressiveness have positive relation to investment as depicted in the table. The desire to be ahead in rolling out new products and to make the firm very aggressive and intensely competitive must be coupled with the relentless search for possible sources of funds and investing them for the purposes mentioned.

By being competitively aggressive, the constant dream to outwit the competitors

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

takes the entrepreneur into the tedious activities of researching, planning, testing, and others to effectively win the battle against the competitors. And again, those require the channeling of funds into the business. There seem to be endless reasons why an entrepreneur needs to invest, but the focus to become aggressive and competitive necessitates being voracious on the generation and utilization of funds.

The relationship of innovativeness to investment is shown in Table 33.

Table 33

Relationship Innovativeness to Investment

INNOVATIVENESS	**COEFFICIENT OF CORRELATION, r**
	Investment
Emphasis on R&D, technological leadership, and innovations	-0.4689**
Very many new lines of products or services are offered	-0.3190ns
Dramatic changes in the product or service lines	-0.4441*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

Remarkably, innovativeness has an indirect relation to investment. The specific measures support this finding. The focus on innovation and dramatic improvements in the product or service lines entails a lower amount of fund utilization. This is because of the learning experienced in the production, which has significantly reduced the need for funds. And also, Filipino entrepreneurs are known to exercise innovation using simple, tried and tested ways, siphoning less money from the budget.

Thus, it can be deduced from the results that again being responsive to situations, bold, and competitive will definitely develop the greed of the entrepreneur for money. However, the money will not go to him personally but will be put into productive use hoping that his business will be more competitive but still relevant and responsive to the society's needs.

5. Influence of Key Success Factors and Entrepreneurial Orientations to Performance

5.1.1. Influence of Key Success Factors to Employment Generation

The influences of key success factors to employment generation are shown in Table 34.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 34

Influence of Key Success Factors to Employment Generation

KEY SUCCESS FACTORS	COEFFICIENT OF REGRESSION	PROBABILITY
Entrepreneur	14.23	.0473*
Enterprise	-19.96	.0348*
Network	-.4123	.9554 ns
Business Environment	18.17	.0180*
Multiple Coefficient of Determination=30.40% Overall Probability=.0358		

Legend: not significant (ns) significant(*) highly significant(**)

One can see clearly from the table that key success factors such as entrepreneur, enterprise, and business environment have significant influences to employment generation. The network factor has no significant contribution to the said performance variable. Considering the probability of each significant key success factor, the business environment (p=.0180) has the greatest impact, followed by enterprise (p=.0348) then the entrepreneur (p=.0473).

The results imply that a good business environment, effective enterprise and skilled entrepreneur are predictors of employment generation.

The multiple coefficient of determination of 30.40% to the generation of employment is attributed to the change in the business environment, enterprise, and entrepreneur. It further means that there are about 69.60% variables, which are unaccounted for. This means that there are other key success factors not included in this study which are possible predictors of employment generation.

5.1.2. Influence of Key Success Factors to Average Sales

The influences of the key success factors to average sales are presented in Table 35.

Table 35

Influence of Key Success Factors to Average Sales

KEY SUCCESS FACTORS	COEFFICIENT OF REGRESSION	PROBABILITY
Entrepreneur	3199964.88	.5820ns
Enterprise	-1611408.1	.7949ns
Network	15292654.6	.0464*
Business Environment	291276.76	.9406ns
Multiple Coefficient of Determination=10.29% Overall Probability=.0494		

Legend: not significant (ns) significant(*) highly significant(**)

The table shows that only one key success factor has a positive impact on average

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

sales, and that is network (p=.0464). This suggests that the network of the entrepreneur is a catalyst of sales. The friends and family members of the entrepreneurs subjected in the study assist them in promoting their products, thereby driving up their sales. The other key success factors have no significant contributions in generating revenues.

The multiple coefficient of determination of 10.29% means that average sales may be credited to the network of the entrepreneur-respondents. This further implies that there are about 89.71% other variables with possible influences on average sales, which were not taken into account in this study.

5.1.3. Influence of Key Success Factors to Investment

Table 36 reveals the way the success factors impact investment.

Table 36

Influence of Key Success Factors to Investment

KEY SUCCESS FACTORS	COEFFICIENT OF REGRESSION	PROBABILITY
Entrepreneur	916881.83	.7333ns
Enterprise	311502.88	.9413ns
Network	-1005009	.0328*
Business Environment	-470011.9	.7957ns
Multiple Coefficient of Determination=12.06% Overall Probability=.0480		

Legend: not significant (ns) significant(*) highly significant(**)

It is illustrated in the table that network key success factor (p=.0328) has significant influence on investment. This leads to the conclusion that network can forecast the outcome of investment for the business. The other key success factors such as entrepreneur (p=.7333), enterprise (p=.9413), and business environment (p=.7957) have no impact on investment.

The multiple coefficient of determination of 12.06% indicates that that there are about

87.94% variables that are unaccounted for. This means that there is a big chance that other key success factors, which can forecast investment may be further discovered.

5.2.1. Influence of Entrepreneurial Orientations to Employment Generation

The way employment generation is influenced by the entrepreneurial orientations is presented in Table 37.

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Table 37

Influence of Entrepreneurial Orientations to Employment Generation

ENTREPRENEURIAL ORIENTATIONS	COEFFICIENT OF REGRESSION	PROBABILITY
Innovativeness	9.083	.0191*
Proactiveness	-3.430	.6283ns
Risk Taking	-8.327	.0345*
Competitive Aggressiveness	0.9575	.8904ns
Autonomy	0.9935	.8306ns
Multiple Coefficient of Determination = 17.52% Overall Probability = .03612		

Legend: not significant (ns) significant(*) highly significant (**)

From the data, innovativeness (p=.0191) and risk taking (p=.0345) have significant influence to employment generation. However, innovativeness has greater impact on hiring more employees than risk taking. Other entrepreneurial orientations, more specifically, proactiveness (p=.6283), competitive aggressiveness (p=.8904) and autonomy (.8306) have no significant contributions to employment generation.

The data implies that an out of the box thinking and taking risks are predictors of employment generation.

The multiple coefficient of determination of 17.52% implies that there are about 82.48% variables, which are not considered. This means that there are other "possible" undiscovered entrepreneurial orientations, which may predict employment generation. This further implies that 17.52% variance in the generation of employment is attributed to the change in the entrepreneur's innovativeness and risk taker attitude.

5.2.2. Influence of Entrepreneurial Orientations to Average Sales

Table 38 shows the influence of entrepreneurial orientations to average sales.

Table 38

Influence of Entrepreneurial Orientations to Average Sales

ENTREPRENEURIAL ORIENTATIONS	COEFFICIENT OF REGRESSION	PROBABILITY
Innovativeness	-4899544	.0052**
Proactiveness	1607307	.0340*
Risk Taking	7303434.6	.0016**
Competitive Aggressiveness	-1862482	.0273*
Autonomy	378062.2	.7306ns
Multiple Coefficient of Determination = 65.16%, Overall Probability = .0051		

Legend: not significant (ns) significant(*) highly significant (**)

It reveals that innovativeness (p=.0052), proactiveness (p=.0340), risk taking

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(p=.0016), and competitive aggressiveness (p=.0273) have positive impacts on average sales. Based on the probability, risk taking is the greatest influencer of sales, followed by innovativeness. Competitive aggressiveness and proactiveness have lower influences, thereby contributing less to the multiple coefficient of determination. Autonomy has no significant contribution to the said performance variable.

The multiple coefficient of determination of 65.61% means that average sales may be credited to the innovativeness, proactiveness, risk taking, and competitive aggressiveness of the entrepreneur. This further implies that there are about 34.84% other variables with possible influences on average sales.

5.2.3. Influence of Entrepreneurial Orientations on Investment

Table 39 depicts the power of entrepreneurial orientations on investment.

Table 39

Influence of Entrepreneurial Orientations to Investment

ENTRERENEURIAL ORIENTATIONS	COEFFICIENT OF REGRESSION	PROBABILITY
Innovativeness	-2746999	.0006**
Proactiveness	1039047	.0160*
Risk Taking	1039047	.0002**
Competitive Aggressiveness	3856971	.0131*
Autonomy	-1127329	.8914ns
Multiple Coefficient of Determination = 74.51%/Overall Probability = .0094		

Legend: not significant (ns) significant(*) highly significant (**)

There are four (4) orientations with significant influence on investment. These are risk taking (p=.0002) with the highest influence, followed by innovativeness (p=.0006). Proactiveness (p=.0160) and competitive aggressiveness (p=.0131) have lower influences on investment. The presence of influences in these entrepreneurial orientations means they can determine the direction of investment. Being innovative, proactive, risk taker, and aggressive with the competitors can predict the amount of investment in the firm.

The 74.51% variance in investment leads into the conclusion that any change in it may be attributed to the change in the four (4) orientations, with risk taking leading the pack, followed by innovativeness, competitive aggressiveness, and proactiveness.

6. Implication of the Study to Business Administration

This study on key success factors and entrepreneurial orientations of the entrepreneur-beneficiaries of the OTOP program in the province of Tarlac is very significant to the field of Business Administration and small business management in

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the country. It supports the relevance of success factors and entrepreneurial orientation in the quest towards the attainment of good business performance. The evaluation on the relationships and influences of the success factors and entrepreneurial orientations on performance, along with the knowledge that were generated from it, may be explored by the entrepreneurs which possibly help them craft their own recipes of entrepreneurial success. This great output may be extended to future businessmen, and may also serve as inspiration to students taking up business and entrepreneurship, teachers, researchers, and agencies related to business.

Since there were key success factors and entrepreneurial orientations that were found to have relationship with each of the performance variables, we partially reject Hypothesis 1.

Hypothesis 1. There is no significant relationship between the performance variables and the key success factors and the entrepreneurial orientations of the OTOP beneficiaries.

And also, based on the results that some success factors and entrepreneurial orientations have influence on each of the performance variables, we relatively reject the second hypothesis.

Hypothesis 2. The key success factors and the entrepreneurial orientations of the OTOP beneficiaries have no significant impact on the performance of their businesses.

APPENDIX

APPENDIX A
QUESTIONNAIRE

Name of business: _____

Address: _____

Year established: _____

Name of owner/owners: _____

I. Performance Indicators

Employment Generated: _____ (from start to present)

Average Sales for the past 3 years: _____

Investment: _____ (from start to present)

II. Key Success Factors*

1. What are the things that made your business successful? For every key success factor identified, describe the degree of importance.

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Key Success Factors	**Importance**				
	Unimportant (1)	Not very important (2)	Mildly important (3)	Very Important (4)	Extremely important (5)
1. Good management skills					
2. Charisma, friendliness					
3. Previous business experience					
4. Hardwork					
5. Ability to manage personnel					
6. Social skills					
7. Reputation for honesty					
8. Appropriate training					
9. Marketing /sales promotion					
10. Good product at competitive price					
11. Good customer service					
12. Maintenance of accurate records					
13. Support of family and friends					
14. Position in society					
15. Satisfactory government					

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support					
16. Access to capital					
17. Political involvement					

The questionnaire was developed by Hung M. Chu (Chu and Katsioloudes, 2001)

Items 1- 7: Entrepreneur

Items 8-12: Enterprise

Items 13-14: Network

Items 15-17: Business environment

II. A. Entrepreneurial Orientation

1. How do you define your focus as an entrepreneur? Describe the intensity of that focus.

EO Scale**

Innovativeness		
In general, I the manager of my firm favor….		
A strong emphasis on the marketing of tried-and-true products or services.	1 2 3 4 5 6 7	A strong emphasis on R&D, technological leadership, and innovations.
How many lines of products or services has your firm marketed in the past five years (or since its establishment)?		
No new lines of products or services.	1 2 3 4 5 6 7	Very many new lines of products or services.
Changes in product or service lines have been mostly of a minor nature.	1 2 3 4 5 6 7	Changes in product or service lines have usually been quite dramatic.
Proactiveness		
In dealing with the competitors, I…		
Typically respond to actions which competitors initiate.	1 2 3 4 5 6 7	Typically initiate actions to which competitors then respond.
Seldom have the first business to introduce new products/services, administrative techniques, operating technologies, etc.	1 2 3 4 5 6 7	Often have the first business to introduce new products/services, administrative techniques, operating technologies, etc.
Typically seek to avoid competitive clashes, prefering a "live-and-let live" posture.	1 2 3 4 5 6 7	Typically adopt a very competitive, "undo-the-competitors" posture.
Risk Taking		
In general, I as the manager have…		
A strong proclivity for low-		A strong proclivity for high

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risk projects(with normal and certain rates of return).	1 2 3 4 5 6 7	risk projects (with chances of very high returns).
In general. I as the manager believe that….		
Owing to the nature of the environment , it is best to explore it gradually via cautious, incremental behavior.	1 2 3 4 5 6 7	Owing to the nature of the environment, bold wide-ranging acts are necessary to achieve the firm's objectives.
When confronted with decision-making situations involving uncertainty , I….		
Typically adopt a cautious "wait-and see" posture in order to minimize the probability of making costly decisions.	1 2 3 4 5 6 7	Typically adopt a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities.
Competitive Aggresiveness		
In general, I being the entrepreneur have a….		
Strong tendency to "follow the leader" in introducing new products or ideas.	1 2 3 4 5 6 7	Strong tendency to be ahead of other competitors in introducing novel ideas or products.
My firm makes no special effort to take business from competition.	1 2 3 4 5 6 7	My firm is very aggressive and intensely competitive.
Autonomy		
The firm…		
Supports the efforts of individuals and/or teams that work autonomously.	1 2 3 4 5 6 7	Requires individuals or teams to rely on the manager to guide their work.
In general, I as the entrepreneur believe that….		
The best results occur when individuals and/or teams decide for themselves what business opportunities to pursue.	1 2 3 4 5 6 7	The best results occur when the manager provide the primary impetus for pursuing business opportunities.
In my firm		
Individuals/employees, and/or teams pursuing business opportunities make decisions on their own without constantly refering to their supervisors.	1 2 3 4 5 6 7	Individuals/employees and or teams pursuing business opportunities are expected to obtain approval from their supervisors before making decisions.
Employee initiatives and inputs play a major role in identifying and selecting he entrepreneurial	1 2 3 4 5 6 7	The manager plays a major role in identifying and selecting the entrepreneurial

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opportunities the firm or business pursues.		opportunities the business pursues.

*****Adopted from the studies of Miller/Covin and Slevin (1989), Lumpkin and Dess (2001) and Lumpkin, Cogliser, and Schneider (2009)***

APPENDIX B
Active OTOP Tarlac Beneficiaries

Name of Business	Entrepreneur	Company Address	Product Line
1. Aroma Anao	Perry Grande	Pob. 1, Anao, Tarlac	Ylang Ylang essential oil, perfumes
2. Biossence	Ronald Guerrero	Brgy. Sa. Jose South, Anao, Tarlac	Soaps and detergents
3. Francia's Mango Delicacies	Ma. Lourdes Francia	Brgy. San Roque, Bamban, Tarlac	Choco-mango delicacies
4. Consolacion Dela Cruz Meat Dealer	Consolacion Dela Cruz	Camiling Public Market, Camiling, Tarlac	Chicharon Camiling, processed meat
5. Lilia Martin Meat Dealer	Lilia Martin	Camiling Public Market, Camiling, Tarlac	Chicharon Camiling, processed meat
6. Rosalina Soriano Meat Stall	Rosalina Soriano	Camiling Public Market, Camiling, Tarlac	Chicharon Camiling, processed meat
7. Mila's Tinapa Factory	Mila Tolentino	Brgy. Talaga, Capas, Tarlac	Tinapa (smoked fish) processing
8.Talaga Smoked Fish	Maria Tuazon	Brgy. Talaga, Capas, Tarlac	Tinapa (smoked fish) processing
9. Luisa's Meat Products	Luisa Gutierrez	Brgy. San Jose, Concepcion, Tarlac	Tocino, longganisa, ham, hotdog
10. Stacy's Food Products	Luisa Gutierrez	Brgy. San Jose, Concepcion, Tarlac	Tocino, longganisa, ham, hotdog
11.Stephen's Meat Products	Yolanda Tiamzon	Brgy. San Jose, Concepcion, Tarlac	Tocino, longganisa, chicharon
12. Gene's Sugarcane-Based Products	Eugene Capinding	Brgy. Danzo, Gerona, Tarlac	Processed sugarcane, panucha, vinegar
13. Yadao Sugarcane Products	Naty Yadao	Gerona, Tarlac	Sugarcane based products
14.W. Balaba Upgraded Muscovado Plant	Apolonio Balaba	Brgy. Malayep, Gerona, Tarlac	Muscovado sugar blocks
15. AITI Agro Coop, Inc.	Helen Matsuoka	Brgy. San Roque, La Paz, Tarlac	Fresh okra

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16. Great Eastern, Inc.	Sonny Lumbang	Brgy. Balanoy, La Paz, Tarlac	Fresh okra
17.Greenstar Phils., Inc	Rolando Sarte	Brgy. Caramutan, La Paz, Tarlac	Fresh okra
18. HI-LAS Marketing	Bobby Amores	Brgy. Sierra, La Paz, Tarlac	Fresh okra
19. Sungreen Farms	Aurea Calimlim	Brgy. Dumarais, La Paz, Tarlac	Fresh okra
20. Nambalan Woodcraft and Furniture	Teofilo Bacho	Brgy. Nambalan, Mayantoc, Tarlac	Wooden furniture
21. Don Benito Sweetpotato Wine	Vida Bagamaspad	Poblacion, Moncada, Tarlac	Wine
22. Paniqui Water Lily	Sylvia Soriano	Poblacion, Paniqui, Tarlac	Water lily bags, novelty items
23. Tresvalles Corn Husk Flowers	Beth Tresvalles	Poblacion, Pura, Tarlac	Corn husk handicrafts
24. R. Molina Food Products	Rodolfo Molina	Brgy. Linao, Pura, Tarlac	Chichacorn (Corn crunch)
25. Linao Farmers MPCI	Cerelino Gamboa	Brgy. Linao, Pura, Tarlac	Corn production
26. AMREY Fashion Wear	Amelia Beltran	Brgy. Guiteb, Ramos, Tarlac	Crochet and knitted blouses
27. D' New Ramos Crochet	Saturnina Buccat	Brgy. Pance, Ramos, Tarlac	Crochet blouses and dresses
28. DUFMAC Brooms	Roseller Toledo	Poblacion, San Clemente, Tarlac	Tiger grass production, soft brooms manufacturing
29. Western Furniture MPCI	Samuel Tababa	Brgy. Iba, San Jose, Tarlac	Wooden furniture, door, jambs
30. San Manuel Malunggay	Jose Villa Agustin, Jr.	Poblacion, San Manuel, Tarlac	Malunggay production
31. Wood Inspirations Crafts	Karmen Blesilda Pascual	Gabay Street, Pob. East, Sta.Ignacia, Tarlac	Bamboo based products
32. Pascasio Pottery	Tony Pascasio	Poblacion, Sta. Ignacia, Tarlac	Pottery products
33. 3FGR Enterprise	Rico Ramos	Brgy. Calingcuan, Tarlac City	Home made peanut butter, processed fruit jams
34. Betty's Native Cakes	Jean Junio	18 San Roque, Tarlac City	Native cakes
35. Cindy's Bakeshop	Benigno Chua	Poblacion, Tarlac City	Cakes, breads, and pastries
36. Gertie's Bakeshop	Gertrudes Garcia	Capitol Gardens Subd., Tarlac City	Cakes, breads, and pastries

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37. Homemade by URDU	Myrna Agatha Joy Sarinas	Burgos St., Tarlac City	
38. Kevynel's Food Products	Hector Ramos	Zone 5, Maliwalo, Tarlac City	Sweet beans
39. Lita's Delicacies	Carmelita Yumang	Brgy. Baras Baras, Tarlac City	Pastillas, barquiron, tamarind candy
40. Macapinlac Cake House	Henry Macapinlac	Poblacion, Tarlac City	Cakes and pastries
41. Potter's Hand Processed Foods	Susan Dy	Blossomville Subd., Tarlac City	Chili garlic paste, vinegar, Chinese bagoong
42. Rosemary's Bakeshop	Divina Fernandez	Brgy. San Rafael, Tarlac City	Yema roll, baked products
43. Tita Glo's Delicacies	Ma. Gloria Capaz	18 San Roque, Tarlac City	Brownies
44. Lalapac Sugarcane Farmers MPC	Noly Lorenzo	Brgy. Lalapac, Victoria, Tarlac	Processed sugarcane, panucha, vinegar, basi wine

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An Overview of Smart Farming Production Technology for the Advancement of Home-grown Farmers in the Philippines

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ABSTRACT

This article explores the technologies that can be used to establish smart farming in the Philippines, as well as the various smart systems that have been used to aid home-grown farmers. The emergence of smart agriculture and farming is a method that heavily integrates digital technology in order to increase food production while minimizing input costs. The importance of this technology has a significant effect on farmers and investors as a result of technological advancements. It should also be recognized that numerous promotions requiring government funding for the establishment of smart farming technology in the Philippines has been addressed.

Keywords: Smart Farming; Hydroponics; Aquaponics; Aeroponics

INTRODUCTION

In the Philippines, almost half of the population lives in rural areas and relies on agriculture for a living; among them are indigenous people, landless farmers, and fishermen [1]. In general, farmers on different islands in the Philippines operate independently using conventional methods, and their management of farm produce to end-users is facilitated at low prices by middlemen. Micro-propagation protocols for bananas, coconuts, legumes, and oilseed crops are well known [2].

In the first quarter of 2021, the value of agricultural output fell by -3.3 percent at constant 2018 rates. This was attributed to a decrease in livestock and poultry demand. Crops and fisheries, on the other hand, also increased productivity [3]. Despite this condition, the Philippines is working to modernize and improve its agriculture industry, with both the government and private firms encouraging the use of advanced technologies and smart farming practices to raise harvests and reduce losses [4].

Agriculture's creation was a watershed moment in human history. The willingness of fully modern humans to change the atmosphere to produce enough food to support population growth is the first major improvement in the relationship between fully modern individuals and society. Agriculture ushered in a slew of new developments, ranging from the use of fire and cooked food to self-driving machinery [5].

Hence, smart farming is seen as the agricultural future because it produces higher quality crops by making farms more intelligent in sensing their controlling parameters [6].

SIGNIFICANCE OF SMART FARMING TECHNOLOGY

Agriculture routinely uses sophisticated technologies such as robots, temperature and moisture sensors, aerial images, and GPS technology. These cutting-edge devices, precision agriculture, and robotic systems enable businesses to be more profitable, efficient, safe, and environmentally friendly [7].

Thus, technology is critical to the development of the farming industry and the improvement of agribusiness. Researchers have successfully grown crops in deserts and other harsh environments using genetic engineering, which involves inserting traits into established genes in order to produce pest-resistant, drought-resistant, and plant pathogen-resistant crops.

Moreover, this technology will enhance insect or pest resistance, herbicide or drought tolerance, and disease resistance, providing farmers with a new tool for increasing crop yield. Farmers have used plant breeding and selection techniques to increase crop yield with the assistance of researchers. Technology is also used to protect crops by tracking growth and detecting plant diseases. Without the physical involvement of farmers, automation allows for the consistent distribution of fertilizers, pesticides, and water throughout fields [8].

Lastly, innovative agriculture ensures that new farming and agricultural development models emerge, introducing innovative techniques on how food is produced and distributed. These methods allow more economies and regions to keep up with changing trends and meet the demands of modern living while ensuring sustainably grown food. [9].

SMART FARMING TECHNOLOGY

Hydroponics Farming

Hydroponic farming is a method of growing plants in water without soil using mineral nutrient solutions. The hydroponic gardener controls the nutrient content of the liquid solution used to water the plants [10].

Common Types of Hydroponics System

1. Nutrient Film Technique (NFT)

A method of cultivating plants in which plant roots grow in shallow and circulating hydroponic nutrient layers, allowing plants to receive adequate water, nutrients, and oxygen. Plants grow in layers of polyethylene, with plant roots immersed in nutrient-rich water that is constantly pumped by a pump [11].

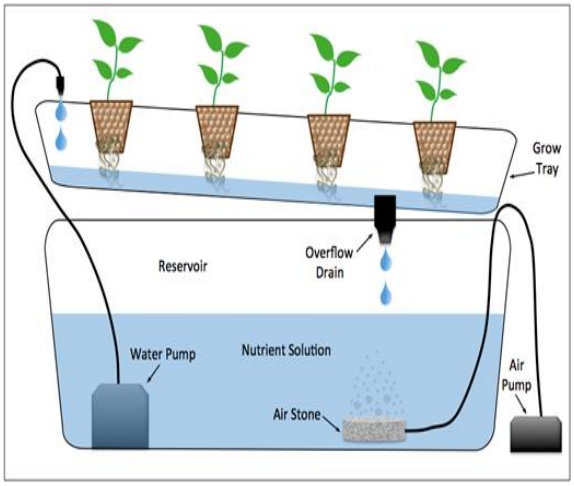

Figure 1. Diagram of the Nutrient Film Technique (NFT) hydroponic system [12]

2. Wick Systems

It is considered the most basic hydroponic device. The Wick system is classified as a passive system, which means it has no moving parts. Your unique Growth Technology nutrient solution is drawn up into the expanding medium through a number of wicks from the bottom reservoir. This device will work with a number of mediums, including perlite, soil, and coco [13].

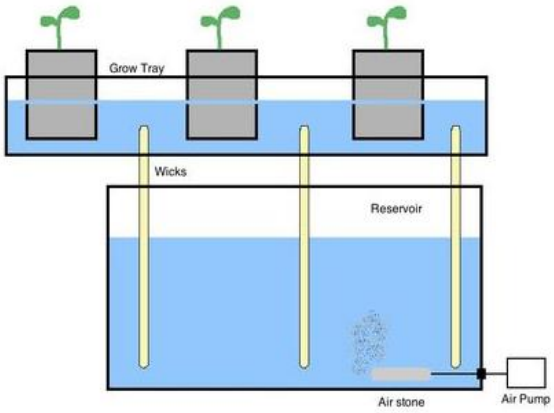

Figure 2. Diagram of the Wick System [14]

3. Deep Water Culture (DWC)

It is a hydroponic method of plant production by suspending the roots of the plant in a solution of oxygenated, rich in nutrients. This system uses rectangular tanks of less than one foot deep filled with a nutrient-rich solution and plants floating on

Styrofoam panels, also known as Deep Flow Technique (DFT), Floating Raft Technology (FRT), or Raceway [15].

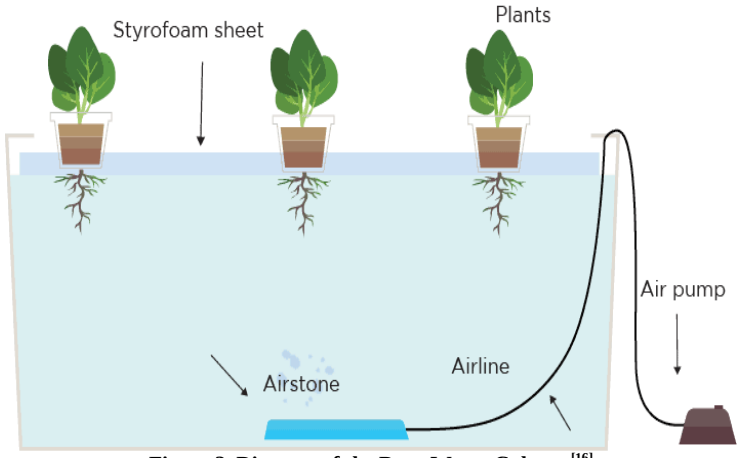

Figure 3. Diagram of the Deep Water Culture [16]

4. Ebb and Flow (Flood and Drain)

It is a hydroponics technique that involves flooding the growth media with nutrient solution for a set period of time, after which the unabsorbed nutrient is returned to the tank. Normally, this hydroponics device uses a timer to fill the water, resulting in inefficient usage of nutrient solution [17].

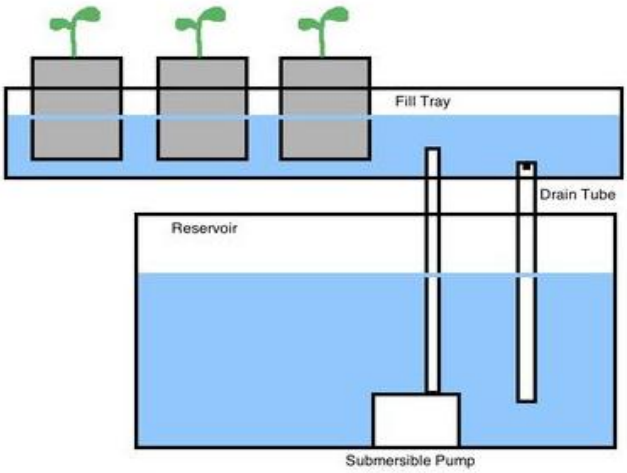

Figure 4. Diagram of the Ebb and Flow [18]

Aquaponics Farming

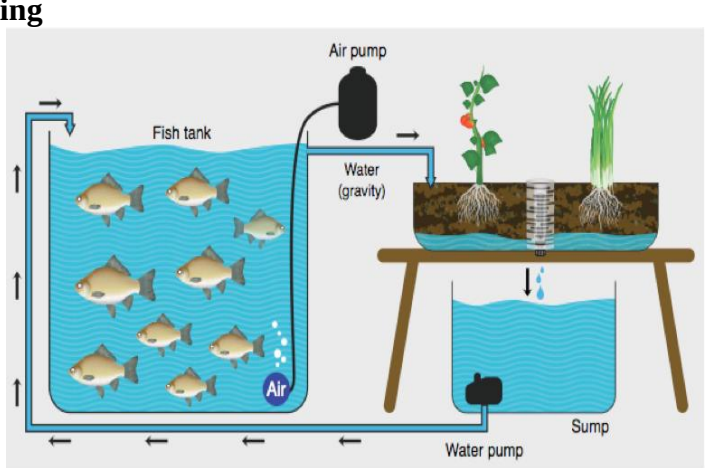

Figure. 5. Diagram of the Aquaponics [19]

In an aquaponics system, water from an aquaculture system is fed into a hydroponic system where by-products' are broken down by nitrifying bacteria first into nitrites and then into nitrates, which are used as nutrients by the plants [19]. A symbiotic relationship between two food production disciplines: (1) aquaculture, the farming of aquatic species, and (2) hydroponics, the cultivation of plants in water without soil. Aquaponics is a closed recirculating device that incorporates the two. A typical recirculating aquaculture system filters and eliminates organic matter ("waste") that accumulates in the water, ensuring that the water is safe for the fish [20].

Aeroponics Farming

In Aeroponics, the nutrient solution is sprayed onto the roots by moving it through misters inside the root region, either continuously or several times per hour [21].

The plant you want to develop is suspended in an air space with an atmosphere that is either completely closed or semi-closed. As a result, it is best achieved in a closed, regulated environment where you can monitor the amount of light, air, and nutrient-rich water spray that is fed into the plant [22].

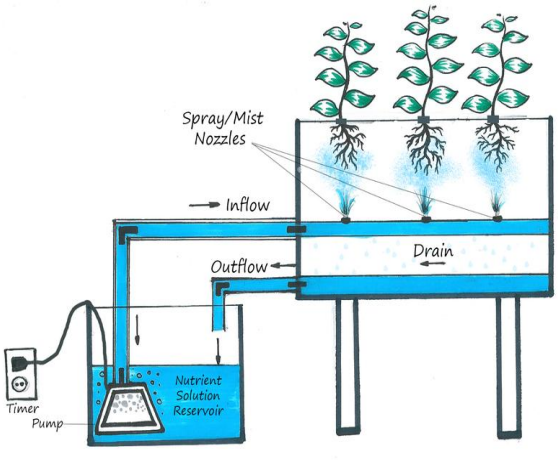

Figure 6. Diagram of Aeroponics [22]

GOVERNMENT SUPPORT TO SMART FARMING

In the Philippines, the local government, led by the Department of Agriculture, is aiming for a 2.5 percent growth this year through further incorporation of technology in agriculture to increase productivity, connectivity, and service delivery to beneficiaries. By focusing on and closely implementing 'Agriculture 4.0,' or the fourth agricultural revolution that encourages the use of smart farming technology, the country would have a better chance of having a better 2021 in terms of agriculture [23].

Agriculture Secretary William Dar released a memorandum to all DA executives, attached agencies and companies, services, and regional offices directing them to "pursue an inclusive approach on these main strategies to accelerate the transition into a new and industrialized Philippine agriculture." [24].

Another agency distinguished in its Labor Market Intelligence report "Soils to Satellites," the Technical Education and Skills Development Authority (TESDA) has been published covering practical topics such as automation in smart greenhouses, agricultural drones, IoT solutions to agricultural problems, and case studies in selected ASEAN countries in smart agriculture applications [25].

CONCLUSION

Some technologies will need to be developed specifically for agriculture, while other technologies already developed for other areas could be adapted to the modern agricultural domain such as autonomous vehicles, artificial intelligence and machine vision and smart farming.

Moreover, as farming in the Philippines faces several problems, proactive solutions like ICT must be implemented together with the full support of the government. Similarly, other major players, such as multinational companies, agricultural and fisheries industry leaders and organizations, and agricultural state

universities and colleges (SUCs), should work together to elevate home-grown farmers in the country.

Lastly, if modern agriculture is applied widely in the near future, millions of farmers will be able to benefit from the acquisition and development of smart farming production technology.

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Internet of Things in the Philippine Agribusiness

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Abstract: *This article focused on the benefits, drawbacks, and present state of IoT in farming in the Philippines. Aligning agriculture with readily available technologies to improve production has been identified to have a significant impact in the inclusive growth and rural development of a nation. This literature review clearly suggests that a comprehensive framework of IoT in agribusiness is imperative and worth exploring in order to completely amass its numerous advantages. Relatively, the Philippines could be considered to be on the right track, having been able to craft a three-phase plan involving a variety of factors including technologies to stimulate regional economic development and build new regional agriculture centers.*

Keywords: IoT, Agribusiness, Goals of Agribusiness, Current Status

I. Introduction

The agricultural sector must rise to meet demand despite a rising population that is projected to reach 0.6 billion by 2050, regardless of environmental problems such as adverse weather and climate change. The agriculture industry needs new innovations to obtain a much-needed edge to meet the needs of this rising population. Increase operating efficiencies, lower expenses, minimize waste and boost the quality of their yields, new agricultural applications in intelligent farming and precision agriculture through IoT [1].

The Internet of Things (IoT) is a global knowledge society system that enables advanced services by interconnecting (physical and virtual) things using current and emerging interoperable information and communication technologies [2]. Because of the convergence of multiple technologies, such as real-time analytics, machine learning, commodity sensors, and embedded systems, things have changed [3].

Traditional fields such as embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to the Internet of Things' implementation. In the consumer market, IoT technology is most closely associated with products related to the concept of the "smart home," such as devices and appliances (such as lighting fixtures, thermostats, and home security systems).

Hence, the Internet of Things (IoT) aims to make "dumb" things "smart" by connecting them to one another and to the internet. It enables the remote sensing and control of physical objects, allowing for more direct integration of the physical world and computer-based systems [4].

Moreover, Precision agriculture base on internet of Things (IoT) enables growers and farmers to reduce waste and increase productivity in areas ranging from the amount of fertilizer used to the number of journeys made by farm vehicles, as well as the efficient use of resources such as water, electricity, and so on.

Lastly, farmers can monitor field conditions from any location. They can also choose between manual and automated options for taking action based on this data. For example, if the soil moisture level drops, the farmer can use sensors to trigger irrigation. When compared to the traditional approach, smart farming is far more efficient [5].

II. Significance of Agribusiness

Agriculture exports accounted for an average of 17 percent of total merchandise exports across 94 countries in 2018, according to World Trade Organization data [6]. The transition from agriculture to agribusiness has resulted in numerous advantages. These include less drudgery for laborers, the release of workers for non-agricultural endeavours, higher food and fiber quality, a wider range of products, improved nutrition, and increased mobility of people [7].

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Agricultural practices also lead to a better food protection environment and sustainable food supply, as well as jobs for the majority of the poor in developed countries. However, the practices raise greenhouse gas emissions and lead to global warming, which is why the industry relies on creativity to fix those issues [8].

Agribusiness views the various facets of agricultural commodity production as a whole. Farmers use advanced harvesting techniques, such as GPS to guide activities, to collect livestock and harvest fruits and vegetables. Manufacturers are creating highly powerful self-driving vehicles. The best way to clean and package livestock for shipment is determined by processing plants. Although each business subset is unlikely to engage directly with the customer, they are both concentrated on working effectively in order to keep costs fair [9].

III. Common Goals of Agribusiness

3.1 Source of Livelihood

The ways and means by which people make a living in the country. The definition revolves around resources such as land/property, seeds, food, expertise, finances, social relationships, and their interconnected relationship with an individual community's political, economic, and socio cultural characteristics [10].

3.2 Contribution to National Income

A wider economic indicator at the national level than personal revenue. National revenue covers payments to people (wages and salaries, as well as other benefits), payments to the government (taxes), and residual income by the private sector (depreciation and undistributed profits), fewer changes (subsidies, government and consumer interest, and statistical discrepancy) [11].

3.3 Food Security

This is the sense that all people at all times have access to enough, safe, and nutritious food that satisfies their food needs and nutritional requirements for an active and stable life, physically, socially and economically [12].

3.4 Significance to the International Trade

International trade helps countries to expand their markets and access commodities and services that otherwise may not have been available locally. As a result of foreign trade, the economy became more dynamic. This finally leads in more competitive pricing and delivers a cheaper product home to the customer [13].

3.5 Marketable Surplus

This represents the excess crop that will, after a farmer has sold his crop, be sold for profit to offset the costs of sustaining and running his farm. The farmer has fixed costs for equipment, labor costs, fertilizer and mortgage on their property [14].

3.6 Origin of Raw Material

Denotes unprocessed or least processed materials, e.g. raw latex, petroleum, cotton, coal, raw biomass, iron ore, air, logs, water or "any commodity in its natural form of agriculture, land, fisheries, or minerals which underwent a processing process needed to prepare for significant foreign marketing." [15].

IV. Agribusiness Approaches Using IoT

The Internet of Things (IoT) has an effect upon the lives of everyone, rendering all wise, current and potential. It is a network of various machines that create a network that configures itself. Smart Farming's latest advances of IoT usage will by day transform the face of traditional farming practices into optimal, cost-efficient farmers as well as reducing crop waste. The aim is to provide a technique that can communicate with farmers on various platforms [16]. The influence of the Internet of Things (IoT) and mobile devices in today's world is undeniable. It has now spread nearly everywhere, from the home to the health market, smart cities, fitness, and the manufacturing sector. It can be used in

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almost any industry, and agriculture is no exception. Indeed, IoT and smart devices have the potential to have a huge effect on agricultural activities, freeing farmers from the need to rely on horses and plows[17].

V. COMMON APPROACHES IN AGRIBUSINESS USING IOT

5.1 Data Collected by Smart Agriculture Sensors

Sensors, monitoring system, robots, standalone engines, automatic hardware, variable rate systems, motor detectors, camera buttons and wearable gadgets constitute a core component of farm management approach. This information will be used to track the status of the company as well as the quality of its employees and facilities. The ability to predict production results makes for a smoother delivery of the commodity [18].

5.2 Agricultural Drones

Drones are and increasingly in the agriculture industry as part of an effective approach to sustainable agriculture management that enables agricultural producers, farmers, and farmers to assist in streamlining their activities by rigorous data analysis to obtain effective insights into their crops. The use of drone data to schedule and render ongoing changes, such as use of dikes and emerging fertilizer applications, is facilitated for example by crop tracking. Instead of conventional and work-intensive data collection, products can be reliably tracked from farm to fork using GPS coordinates for each travel point [19].

5.3 Livestock Tracking and Geofencing

Producers can use GPS technology to create landmarks and geofences around specific geographic locations. This aids in livestock rotation by grazing areas, crop preparation, planting, and harvesting in order to increase yield and maintain livestock in specified areas. Via temperature control, GPS-enabled animal monitoring and tracking collars and tags are used to keep track of livestock position, grazing patterns, and general health. By immediately alerting the producer when livestock leave their assigned area, this technology can also help with livestock safety and stock theft prevention [20].

5.4 Smart Greenhouses

Machine learning is used in smart greenhouses to process and remember information about your crops and their ideal climate. Based on their results, these systems can then make recommendations, or growers can use their mobile app to change key factors to achieve higher yield rates. In any case, the ability to monitor your microclimate through a mobile device gives you a lot more control over your operations and what you do with your time [21].

5.5 Predictive Analytics for Smart Farming

Predictive analytics involve the success of good data and incomplete or incorrect data can give insights which are not analyzed in full. Data from in-field sensors, input data collection at each stage, and economic functions of decisions will continue to be crucial for predictive analytics performance. As IoT grows in popularity and data collection becomes more important to operations around the world, the ability to make impactful, constructive, and efficient decisions that can maximize opportunities and efficiencies on the farm remains of interest [22].

VI. CONCEPTUAL FRAMEWORK OF IOT IN AGRIBUSINESS

The layers of the IOT system for agribusiness are depicted in Figure 1. It's also worth noting that various layers are taken into account. There are three (3) parts of it. 1. Computer and contact planes make up the lower layer. 2. Data and data analytics make up the intermediate layer. 3. Device and end-user planes make up the higher layer. A wide variety of software components for individual data collection, modelling, interpretation or visualization operations are present on each layer. [23].

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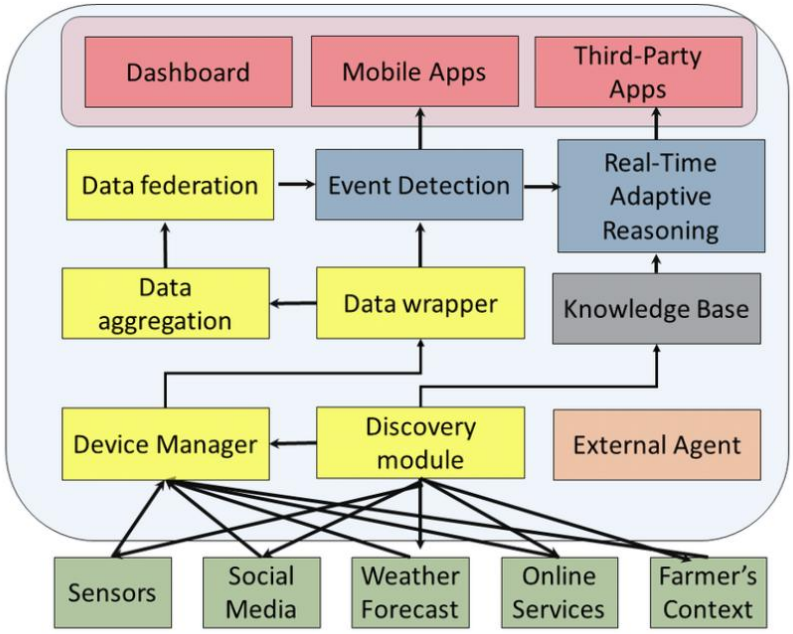

Figure 1: The IOT Framework for Agribusiness [23]

VII. Benefits of IoT In Agribusiness

The Internet of Things (IoT) is a fascinating collection of technology that is already influencing humanity's future. IoT is focused on the idea of gathering data from uniquely recognizable interconnected devices (such as sensors, computers, and mechanical devices), storing it in the cloud, and processing it with intelligent algorithms to achieve common goals [24].

In agriculture, as in other sectors, the Internet of Things offers previously unattainable productivity, resource and cost savings, automation, and data-driven processes. However, in agriculture, these advantages aren't improvements; they're fixes for an entire sector grappling with a slew of dangerous issues [25].

7.1 Excelled Productivity

Today's agriculture is a competition. Farmers must produce more product in the face of deteriorating soil, decreasing land availability, and rising weather variability. Farmers can track their commodity and conditions in real time with IoT-enabled agriculture. They gain insights quickly, can anticipate problems before they occur, and make educated decisions about how to prevent them. Furthermore, IoT solutions in agriculture allow automation, such as demand-based irrigation, fertilizing, and robot harvesting [26].

7.2 Increase

The world's population will hit 9.1 billion by 2050, a 34% increase from today. Almost all of this population growth will take place in developed countries. Urbanization will proceed at a rapid pace, with approximately 70% of the world's population living in cities by 2050. (compared to 49 percent today). Income levels would be several times higher than they are now. Food production (net of food used for biofuels) must increase by 70% to feed this larger, more populated, and wealthier population [27]. Food can be grown in supermarkets, on the walls and rooftops of skyscrapers, in shipping containers, and, of course, in the comfort of everyone's home, thanks to smart closed-cycle agricultural systems.

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7.3 Condensed Capital

The Internet of Things (IoT) is a promising technology that is providing numerous novel ideas to improve agriculture. IoT-based solutions and products are being developed by research institutes and scientific groups to address various aspects of agriculture [28].

7.4 Cleaner Method

Farmers will be able to cut waste and increase output by using IoT technologies in smart farming. This could be due to the amount of fertilizer applied or the number of trips the farm trucks have taken. As a result, smart farming is essentially a high-tech system for producing clean, long-lasting food for the public. It is the introduction of modern ICT (Information and Communication Technologies) into agriculture as well as its application [29].

7.5 Speed and Development

Real-time data analysis can help predict and monitor weather, humidity, crop health, and other variables, improving overall process efficiency. With farmable land becoming scarcer, IoT devices can assist urban greenhouses and other similar systems in simulating optimal farming conditions and facilitating production [30].

7.6 Better-Quality of Product

The rise of OIT and farming is a way for increasing food output while lowering input costs by substantially integrating digital technology [31]. The impact of Big Data applications in Smart Farming extends beyond primary agriculture to the entire food supply chain. Furthermore, smart sensors and devices generate massive amounts of data, enabling unprecedented decision-making capabilities [32].

VIII. Agribusiness Limitation Using IoT

IoT has few limitations in the agribusiness sector. The internet connections in farms are usually poor since most farms are located in rural areas and may not have strong enough internet access to enable rapid transmission speeds. In addition, communication cables, plants, canopies and other physical impediments may be blocked. High Cost of Hardware is another limitation. Currently, farmers are relying on a thinly dispersed sensor network to collect data on farm conditions. Furthermore, cloud connectivity is disrupted. Farmers now collect data on farm conditions on a sparsely distributed sensor network [33].

IX. Current Status of Agribusiness in The Philippines

Turning agricultural agriculture into a thriving agricultural sector involves developing agriculture technologies, providing training in more advanced agriculture techniques, creating stable supply chains, developing transport and agricultural infrastructures, investment and R&D, and securing a sound system for rights of property.

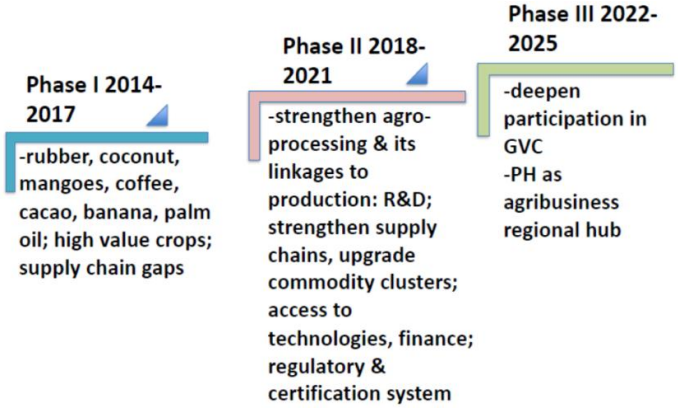

Figure 2: Catalyst to Drive Regional Economic Transformation

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These activities can not only help diversify and enhance the value of agricultural company products, but can also contribute to the Philippine government's inclusive growth and rural development objectives. As a result, the agricultural sector is positioned to make a major contribution to the Philippine economy's industrial development [34].

Fig.2. depicts the three (3) stages of agribusiness transformation in the Philippines, from traditional farming to a globally competitive agribusiness sector. The transformation of economic thrust from 2014 to 2025 is also emphasized.

X. CONCLUSION

The potential of the agricultural IoT industry by installing intelligent technology to improve competitiveness and sustainability in their output must be understandable for large landowners or small farms. Demand can be met with a rapid population growth if crops and small farmers are successfully implementing agribusiness IoT technologies.

Moreover, temporary impediments arise, such as the frequent integration / compliance between sensors from different platforms, the internet connectivity or local network configuration, the volume of Big Data generated and the uncertainties that still persist in farmers' minds. The impact of IoT on agribusiness will become more visible after these minor hiccups are overcome.

Lastly, The Philippines is on pace to enhance agriculture using the internet. Regularities in many industries adopt initiatives to develop the benefits of this technology. By the end of 2025 the Philippines will deepen its participation in IoT and established the agribusiness regional hub.

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Nitrogen Deficiency Mobile Application for Rice Plant through Image Processing Techniques

Geraldin B. Dela Cruz

Abstract: ***Driven by the opportunity that digital devices and robust information are readily available, the development and application of new techniques and tools in agriculture are challenging and rewarding processes. This includes techniques learned that is based on traditional methods, practices, experiences, environmental patterns and human capability. The most sought technique comes from human intelligence that is dynamic, adaptive and robust. Nitrogen deficiency in rice plants can be determined via the color of the leaves. It is dependent on the depth of the green pigment in the color spectrum present in the leaves. Based on these characteristics, the application of computational artificial intelligence and machine vision can be adopted to create assistive technologies for agriculture. In this paper, a mobile application is developed and implemented that can be used to assist rice farmers determine nitrogen deficiency, through the leaf color in rice plants. The application can be used alternatively or together with the traditional protocol of nitrogen fertilizer management. It is mobile, simple and it also addresses some drawbacks of the human eye to distinguish color depths brought about by other factors, like sunlight, shading, humidity, temperature, etc. It utilizes image processing techniques to digitally captured images represented in numerically transformed Red, Green, and Blue color formats. The digital images are then normalized to remove the effects of illumination and then compared using the image/pixel subtraction technique with the base color images converted and extracted from the leaf color chart standard. Eventually, the application determines nitrogen deficiency and suggests the concentration and volume of fertilizer to be applied to the rice plants. Accuracy of the technique is determined by computing the Z statistic score.***

Keywords**: *Algorithms, image processing, fertilizer management, mobile application.***

I. INTRODUCTION

Fertilizer management is governed by processes triggered by specific events and attributes from the environment and most especially from the crop. The method is based on a standard protocol developed by researchers together with the farmers with years of tests and trials. This fertilization protocol is a tedious activity especially for the rice (*Oryza Sativa L.*) plant, it is not as easy as just throwing nutrients into the soil and everything will just be fine. There are some issues to be considered, such as applying too much fertilizer and the plant becomes succulent and susceptible to insect and disease. Too little and the plant grows poorly and unproductive. In the Philippines, majority of the farmers cultivate their farms the traditional way. These farmers apply fertilizers not only based on plant condition but also take into consideration predetermined dates after seeding or transplanting. Not following holistically the protocols established for fertilizer management, farmers suffer the consequences of bad fertilizer management, thus lesser harvest yield. Fertilizers must be applied only when necessary and based on the crops' nutritional status. However, most farmers rely on the age (days after transplanting) of the rice plant and not on its condition. Consequently, this causes a deficiency in the required nutrient of a plant from the fertilizer in terms of growth, development, and yield. Moreover, there are some unaware farmers, that applying fertilizer too soon, will result to undesirable effects on growth and yield of rice and thus have a significant addition to the production cost which is not ideal [1].

II. RELATED WORKS

There have been many developed methods of the proper application of fertilizer [2]. One of the most effective means to determine the volume and when to apply fertilizer is to use the developed Leaf Color Chart (LCC). The LCC is used to assess the plant Nitrogen (N) status. It is an inexpensive tool consisting of four (4) color shades from yellowish green to dark green. The color strips are fabricated with veins resembling those of rice leaves. The assessment will depend on the greenness of the leaf matched to the LCC window. Each window defines a level of N status. This method however, limits the capability of the human eye to distinguish from the colors given in the chart from the colors of the rice plant leaf as evidenced in the findings of the on-farm evaluation. The color matching is relative to the person's color perception so it is recommended that the same person should do the matching. The use of the LCC is also limited to a period of a day due to the effect of sunlight to the colors, both of the leaf and the chart [3], [4].

In the Philippines, the on-farm evaluation of the LCC technique has demonstrated its usefulness for real-time nitrogen management in rice. The increase in N-use efficiency was due to slightly less, same or higher yields grain, with lower levels of N application in the LCC-monitored fields. Savings in N fertilizer of -14 to +53 kg per hectare were realized in farmers' fields of other collaborating countries [5].The work of P. Sanyal and U. Bhattacharya explained that rice deficiencies in the balance of mineral levels can be identified by detecting the change in the appearance of rice leaves [6]. This work is also supported by P. Murakami et al, that changes in foliar color are a valuable indicator of plant nutrition and health.

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The leaf color is measured with visual scales and inexpensive plant color guides that are easy to use, but not quantitatively rigorous, or by employing sophisticated instrumentation including chlorophyll meters, reflectometers, and spectrophotometers that are costly and may require special training [7].

The International Rice Research Institute (IRRI), and the Department of Agriculture (DA) in the Philippines, initiated the NM Rice Mobile application. It applies the concept of Site Specific Nutrient Management (SSNM), a set of scientific principles for optimally supplying rice with essential nutrients. The LCC is covered by SSNM. Farmers dial a toll-free number and a voice response will follow which will direct them to a set of 12 to 15 questions related to the status of the rice plant. Eventually, a text message will be sent to the farmer's phone containing recommendations on fertilizer application duly customized for his field. The mobile application is available in Tagalog, Cebuano, and Ilocano dialects [8].

The paper of S. Pongnumkol, P. Chaovalit and N. Surasvadi, presented a review of the capability of smart phones to becoming a very useful tool in agriculture, mainly to their mobility that matches the nature of farming, the cost efficiency and accessibility of computing power. It systematically reviewed smart phone applications that utilize built-in sensors to agricultural solutions [9].

Similarly, the work of V. Patodkar et al, presents a developed android software application for sustainable development for farmers. The application assists the farmer in decision making regarding selection of fertilizer, pesticide and time to do particular farming actions. It combines internet and mobile communications with Global Positioning System (GPS) [10].

The system developed by Sanjana, Sivasamy, Jayanth [11] consisted of a mobile application which enables farmers to take digital images of plants using their mobile phones and send it to a central server where the central system analyzes the pictures based on visual symptoms using image processing algorithms to measure the disease type. An expert group will be available to check the status of the image analysis data and provide suggestions based on the report and their knowledge, which is then sent to the farmer as a notification in the application.

Based on the insights from these pieces of literatures, this project aims to apply digital processing techniques in a mobile application that can be used as a tool to assist rice farmers in fertilizer management of the rice plant based on the LCC framework and its guidelines.

The project intends to implement the image normalization technique as a preprocessing method and the digital image pixel subtraction technique as the processing algorithm into a mobile phone application [12]-[14].

The application is to be used in the rice paddy field as an assistive technology for rice plant farmers. It aims also to archive data sampled from the rice field to be used as baseline comparative statistics by other researchers. The framework of the study was inclined on the use of smart mobile phone technology, image processing and rice farming technologies.

III. SYSTEM ARCHITECTURE

A. Application architecture

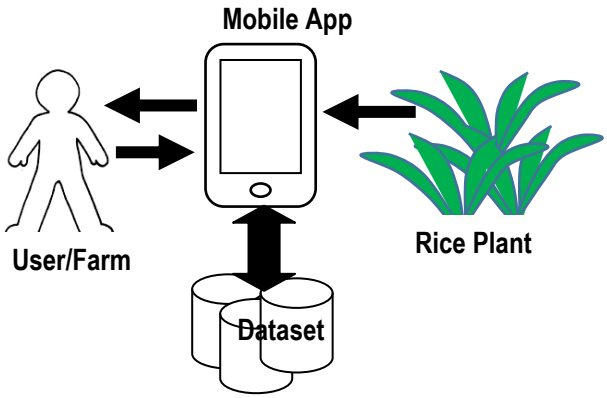

Fig. 1.A system view of the application.

Shown in Fig. 1, is the conceptual framework of the system: the mobile phone application processes sample images of leaves taken from rice plants in the field through its built-in camera device, these images are processed and eventually references the average image against the digitized LCC dataset. This process determines the nitrogen deficiency of the rice plant. The number of samples is dependent on the size of the rice field. Ideally, more samples from a large area, the better the outcome of the mobile application. However, the LCC standard suggests that five (5) leaf samples per hectare taken randomly from the field are sufficient to represent the whole area.

The intelligence of the application relies on the digitized LCC dataset that is used as the basis in determining the nitrogen content of the captured rice plant leaf color. The whole process is integrated into the mobile application: the user launches the application and through the camera of the phone, to take samples of the rice plant leaf. The application converts the images one at a time, calculates the average of the samples and performs image comparison. The method uses the color depths of the captured image from the base image and compares it from the digitized LCC database. Subsequently, the application displays the result, suggesting the amount of fertilizer to be applied. The results are archived in the database for future reference and further study.

B. Computational processing of the application

Fig. 2 presents the computational algorithm of the mobile application. The system takes sample images of rice leaves in the rice field. These images are then processed by converting it to its equivalent Red, Green, Blue (RGB) formats. By subtracting the average value of the sample images from the value of the baseline LCC images present in the application, consequently, a resulting near accurate color value is returned. If the sample images are out the range, then the user is alerted that the image is not a rice leaf. The same procedure is done until the captured image is valid. While the application captures the images, it also records the ten greenness values of the rice leaves.

The average greenness values of the ten images are also stored. The average greenness value of the sample images is then subtracted from the baseline values per window of the digitized LCC. After this process, the indicative result based on the interpretation of the greenness value is displayed. Included in the indicative result is the fertilizer recommendation accordingly to the specified window.

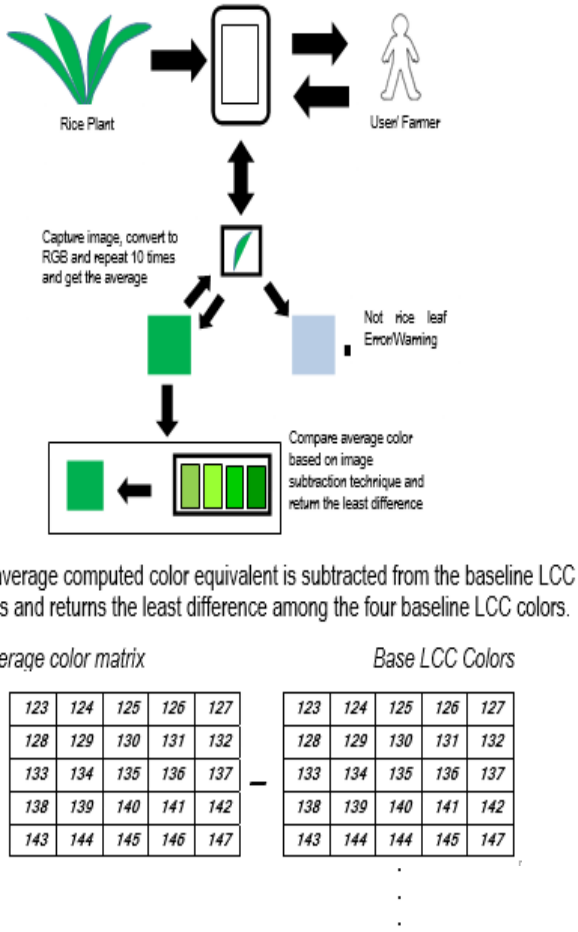

Fig. 2. Processing mechanism of the mobile application.

The RGB color space of the captured bitmap image is used as the numerical representation of the image. The RGB data value of each pixel's color sample has three numerical values to represent the colors Red, Green, and Blue. These three RGB components are three 8-bit numbers for each pixel. Each 8-bit RGB component can have 256 possible values, ranging from 0 to 255.

To get the area of concern from the image, the height and width of the bitmap is first calculated, which is denoted by:

$$Z = (0...x, 0...y) \quad (1)$$

Where:
Z = bitmap image
x = x coordinate plane
y = y coordinate plane

The color value of each pixel is represented in (2) denoted by:

$$P_{(x,\,y)} = (R, G, B) \quad (2)$$

Where:

$P_{(x,\,y)}$ = pixel in the x and y coordinate plane
(R,G,B) = (0...255, 0...255, 0...255)

Color normalization is also applied to the pixels to reduce the effects of light. Normalization of the color space of the image removes highlighted regions and shadows this makes it easier to detect the color of the leaf. Based on equation (2), the normalization method is presented below:

$$Total = (R + G + B) \quad (3)$$

$$R' = round((R / Total) * 255) \quad (4)$$

$$G' = round((G / Total) * 255) \quad (5)$$

$$B' = round((B / Total) * 255) \quad (6)$$

Thus, the normalized images are denoted by the equation in (7):

$$P1 \mid 2_{(x.y)} = (R', G', B') \quad (7)$$

The pixel subtraction technique is as simple as taking two images as input parameters, this mechanism produces a third image whose pixel values are simply the difference of the corresponding pixel values from the two images. It is also often possible to just use a single image as input and subtract a constant value from all the pixels. Some versions of this technique produce the absolute difference between pixel values, rather than the straightforward signed output.

The subtraction of two images can be performed straightforwardly in a single pass using the formula in equation (8).

$$[Q_{(i,\,j)} = P1_{(i,\,j)} - P2_{(i,\,j)}] \quad (8)$$

Where :
Q = the output value
P1 = the first image value
P2 = second image value

Or the absolute differences between the two input images can be computed from equation (9).

$$[Q_{(i,\,j)} = \mid P1_{(i,\,j)} - P2_{(i,\,j)} \mid] \quad (9)$$

Or simply subtract a constant value C from a single image if desired using the formula in equation (10):

$$[Q_{(i,\,j)} = P1_{(i,\,j)} - C] \quad (10)$$

Where:
P1 = first image value
C = baseline image value

The green (G) color component value in a pixel is simply extracted separately to produce the nearest output value.

IV. RESULTS

A. Detection Testing

Tests were conducted on the premise that the algorithm may result and interpret colors from other leaves other than of the rice leaf. Thus, a mechanism was integrated to accurately identify whether the captured image is that of a rice leaf.
Shown in Fig. 3, is the result after capturing thru the mobile phone camera the rice leaf. The image presents the confirmation of the object being a rice leaf which does not display warning or notification of an error. The application converts the image and saves it in RGB format

Fig. 3. Correct rice leaf image.

Fig. 4 and Fig. 5 shows the status screen of the mobile application when a different leaf or an object with the same color of a rice leaf is captured. It is capable of determining that the image taken is not a rice leaf, resulting in the notification display of an error-warning to the user. Not only the difference in color but also the difference between the two objects can be detected, even though the object captured has a similar color with a rice leaf. Fig. 6 shows the indicative results when the application correctly determines the captured image that is of a rice leaf. Consequently, the result of the detection process is displayed. In this case, the leaf is in category 4 of the LCC, which means the plant requires a certain amount of fertilizer. The application will also display the required volume of the fertilizer that should be applied in the rice field.

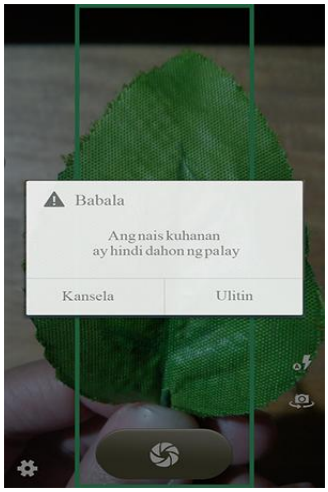

Fig. 4.Error detection warning for a different leaf with similar color.

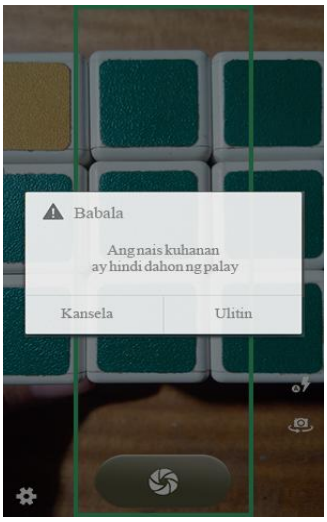

Fig. 5.Error detection warning for a different object with a green color.

Fig. 6.The indicative result when fertilizer deficiency is detected from the rice leaf.

Fig. 7.The indicative result when rice the plant is not fertilizer deficient.

Fig. 7 shows the result when the processed data from the captured image is within category 5 of the LCC, which means, not fertilizer deficient. The application will display a notification to the user that there is no need for fertilizer to be applied to the rice field.

B. Actual Field Test Results

The test data were gathered from the five (5) week actual field testing. The process was synchronized with the growth stages of the rice plant, to get the real colors of the rice plant throughout its different growth stages. The Z-test statistic was used to verify and validate the hypothesis that the developed mobile application using the image subtraction technique does not have a significant difference with the traditional LCC.

The field test consisted of a rice field of approximately three hectares. The area was divided equally into three zones (Area 1, Area 2 and Area 3) due to the geographical contours and for an equal number of samples per area sampled. Thirty (30) leaf sample pictures were taken from each area randomly, these thirty samples were also divided into three (3), so that ten (10) leaf samples for each strip one area, for a total of ninety (90) leaf samples each week.

The field test was done from the vegetation and milking stages of the rice plant, giving a total of 450 leaf samples, with an average of 45 samples. During the field tests, the researchers also synchronized the use of the traditional LCC. This was done so that readings are consistent with the LCC due to the leaf's condition for a short time. This is to lessen the effect of other factors like sunlight, moisture, wind, temperature, shading, etc.

Table- 1: The success rates of the system in the field test

Week	Area 1			Area 2			Area 3		
	a	*b*	*c*	*a*	*b*	*C*	*a*	*b*	*c*
1	6	6	6	8	8	8	6	6	6
2	6	6	6	8	8	8	6	6	6
3	6	6	6	8	8	8	6	6	6
4	7	7	7	7	7	8	9	7	9
5	7	7	7	8	8	8	9	7	10

[a] *$n = 45$ $\bar{x} = 7.08$ $\sigma = 0.03$

Table 1, shows the success rates readings of the mobile application in comparison to the LCC. The study assumed that the null hypothesis is equal to, Ho = 5, which is the mean success rate of the mobile application and the alternate hypothesis is greater than H1 > 5. To test the hypotheses if the application has no significant difference between the traditional LCC, the z-test statistics is employed.

To compute for the z-test statistic the formula in equation (11) is used. The alpha level considered by defaults is 5% (0.05). The rejection region area in the z-table is 0.05, which is equal to a z-score of 1.645.

$$Z = \frac{\bar{X} - \mu_0}{\sigma / \sqrt{n}} \tag{11}$$

Where:

Z = the test statistic, $\bar{x}$ = mean score, σ = standard deviation, n = population, sample, and μ_0 = null hypothesis

Continuing with the computation, the equation is used straightforward. The Z statistic value is then derived in (12):

$$Z = \frac{7.08 - 5.0}{0.03 / \sqrt{45}} = 1.033 \tag{12}$$

Comparing the computed Z-statistic test result score of 1.033 with the z score of 1.645, it shows that the computed Z statistic test score is less than the Z score prescribed in the Z table. This suggests that the null hypothesis is not rejected. Further, the results imply that using the mobile application can be an effective assistive technology for rice farmers and as efficient as the LCC. The accurateness of the system is assured as it has been proven thru statistical analysis that the mobile application does provide significant and similar results compare to the traditional LCC.

V. CONCLUSION

A mobile application was developed and the proposed method was successfully implemented. The results of the field experiment demonstrated that machine vision can be a tool to assist farmers in detecting the level of nitrogen deficiency of rice plant, by implementing image processing techniques as the mechanism. Specifically, the intelligence of the developed system is the application of the image or pixel subtraction algorithm. By using digitally captured bitmap images with their corresponding RGB numerical formats. This technique was proven to be easily executed as a function in the application, using an android based smart phone.

Field test results suggested that the developed mobile application is comparable to the traditional LCC standard. Meaning, they are complementary with each other or can be used individually without a significant difference in their outputs. Similarly, the statistical test result also implies that machine vision can be used as an assistive technology to rice farmers, specific to the detection of nitrogen deficiency of rice plants presented in this study. The implemented detection algorithm for nitrogen deficiency is accurate and efficient. Future endeavors to include other variables like temperature, time of the day, and age of the plant may be considered for the improvement of the application. To cover a larger area and for faster acquisition of images, an unmanned aerial vehicle is also being considered.

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Hydroponics Reservoir Temperature Monitoring and Controlling System under Greenhouse Condition

Amy Lizbeth J. Rico

Abstract: ***An automated reservoir temperature monitoring and controlling system for hydroponic system was developed, calibrated and validated in this study. The automated monitoring and controlling system was developed to monitor and control the reservoir temperature of nutrient solution in hydroponic system. The greenhouse available at the Center for Hydroponics and Aquaponics Technology (CHAT) and locally available materials and hardware for the hydroponics and automation were used in the development of the system. These devices were designed and assembled based on the conceptual framework of the study. The reservoir temperature sensor sends signal to the microcontroller which triggers the turning on/off of water chiller and the mixer. The instruments used were calibrated prior to the performance evaluation and obtained calibration equation for the water temperature sensor is y = x + 0.37. Validation of the automated reservoir temperature monitoring and controlling system was done and the recorded maximum temperature is 31 °C and the minimum temperature is 24 °C. The lettuce planted during the validation has an average height of 14.61 cm and the average leaf count of 12 for the lettuce crops during the 4th week after planting. A total of 4.78 kg of lettuce crop was harvested with an average of 20.6 grams per lettuce crop was obtained. Based on the performance evaluation and validation done on the automated reservoir temperature monitoring and controlling system, it was found to be reliable. This system becomes useful in reducing labor cost, and allows for real-time monitoring of reservoir temperature, therefore increasing farmers' crop productivity and income.***

Index Terms: automation, greenhouse, hydroponics, reservoir temperature, sensor

I. INTRODUCTION

In the present scenario, almost everything can be controlled and operated automatically, but there are still a few important sectors in our country where automation has not been adopted or not been put to a full-fledged use, perhaps because of several reasons such as cost. Agriculture has been one of the primary occupations of man since early civilizations and even today manual interventions in farming are inevitable. Without automation in hydroponics, many growers spend approximately 15-30 minutes a day testing and correcting the system levels. This means that beginning growers will often spend more time on testing parameters until the farmers familiarize themselves with the nutrient levels needed. Also, farmers tend to over-correct one or two of the variables. The automated reservoir temperature monitoring and controlling system keeps the system levels stable and provides the optimal environment for the plants which results to bigger and healthier plants.

Hence, this study is conceptualized to develop an automated system by monitoring the reservoir temperature of the nutrient solution in a hydroponic system for optimum plant growth as this factor can greatly affect the growth of lettuce. Specifically, the study aimed to; (1) install an automated reservoir temperature monitoring and controlling mechanism for the nutrient solution, (2) evaluate the performance of the automated monitoring and controlling device, and (3) determine the response of lettuce on the automated monitoring and controlling device

II. MATERIAL AND METHODS

A. Conceptualization of the Study

The conceptual paradigm of the study is presented in Figure 1. The study aimed to monitor and control the reservoir temperature of the nutrient solution using hydroponic system under greenhouse condition. Through this process, time and labor can be saved as well as real time monitoring of the parameters can be achieved.

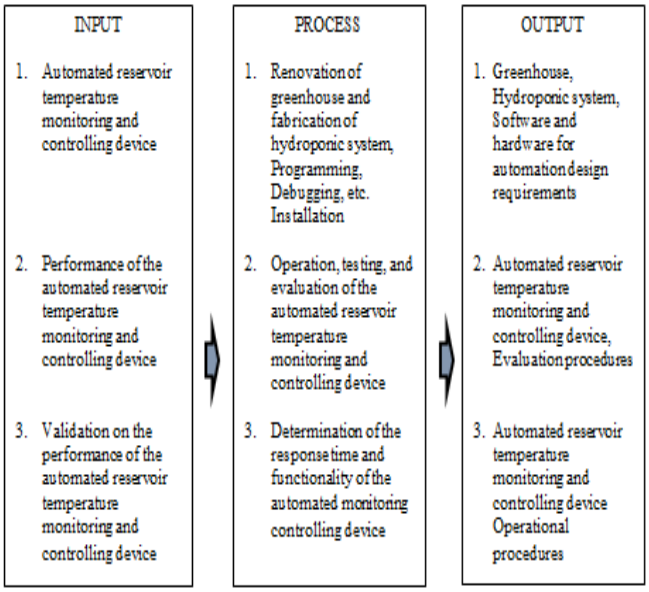

Figure 1. Conceptual framework of the study.

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B. The Production System

The automated hydroponic system used in the study is composed of the structural system, the hydroponic system, and the automation system.The automated reservoir temperature monitoring and controlling was tested in one of the greenhouse facilities located at the Center for Hydroponics and Aquaponics Technology (CHAT) measuring 3.0 meters in width, 4.0 meters in length, and 3.5 in meters height. The frames of the greenhouse are made from 2.54 cm galvanized iron pipes bended and welded together to form a Quonset-type structure. The structure is provided with three roof covers: the insect-proof net in the inner side, the ultraviolet- resistant plastic film in the middle and the gravy woven net shade on the outer side that offers strength and improve aerodynamics to withstand strong wind gust and heavy rains. The available water supply and power supply was used in the operation of the hydroponics system.

The recirculating tube culture system was used in hydroponic system. The hydroponic system was enclosed in the structural system. The grow pipes used was 300.0 cm in length and 0.075 cm diameter. A slope of 1 cm/100 cm of the pipe length was employed for the water to flow through the pipe with ease. The PVC pipes were drilled with 5.08 cm diameter holes and were spaced at 16.5 cm between holes (center to center) and made in 2-layer and 4-column pipe layout. A 150 L reservoir served as the source of water in the hydroponics system where the water was pumped to each growing tubes. The water flow in the hydroponic system was run by a 65-watt submersible pump, 1-2 liters/min flow for each growing tube that lifts the water to the upper layer of the growing tubes. A mixer inside the reservoir was installed to equally dispense the nutrient solution to the reservoir water.

Figure 2 shows the set-up of the automated pH monitoring and controlling device. The automation system served as the main component of the study and was composed of the controls, sensors, and hardware.

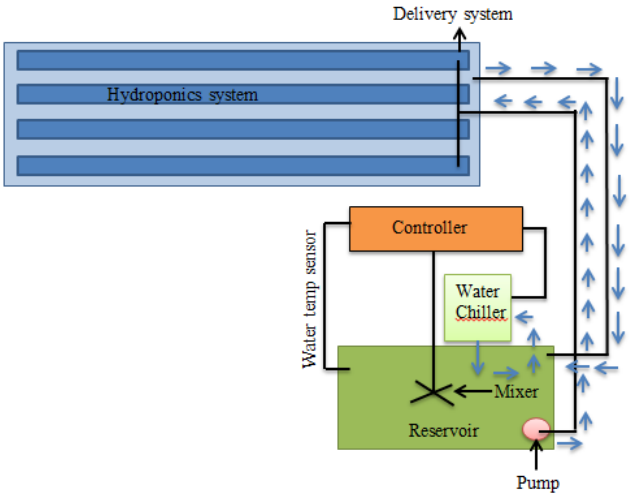

Figure 2. Set-up of the automated reservoir temperature monitoring and controlling device

C. Automation of the Reservoir Temperature Monitoring and Controlling Device

The automated reservoir temperature monitoring and controlling device basically monitor and control the temperature of the nutrient solution in a hydroponic system under greenhouse condition. Sensors were used to determine the reservoir temperature in the reservoir. The block diagram shown in Figure 3 is the layout of the hardware design that was used for the automated monitoring and controlling device. A microcontroller using the Arduino platform was used in programming the automation of the reservoir temperature monitoring and controlling device. Using this data, the microcontroller adjusts the temperature of the water in the system by turning on the mixer and the water chiller

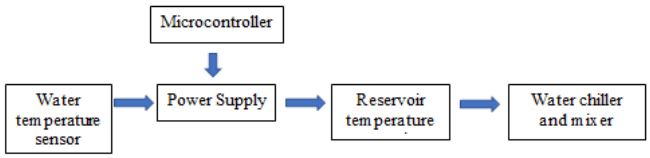

Figure 3. Block diagram of the automated reservoir temperature monitoring and controlling system

Shown in Figure 4 is the flow diagram of the automation used in the study. The LCD is initialized when the automation system is turned on. The reservoir temperature range of 24ºC - 30ºC for the nutrient solution was entered in the system. These ranges determine when the chiller and the mixer will be turned on. and determined using the water temperature sensor submersed into the reservoir. If the reservoir temperature reading is above 30ºC , the sensor sends signal to the microcontroller to trigger the chiller and the mixer to turn on. When the entered reservoir temperature range is attained, the sensors send signal the microcontroller to turn off the chiller and the mixer.

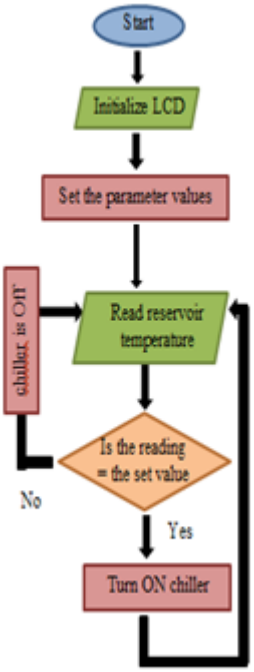

Figure 4. Flow diagram of the automated system

D. Calibration of the Water Temperature Sensor

The water temperature sensor was calibrated in order to achieve precision and accuracy.

The hourly reading for 24-hour period in the sensor was compared with the reading from the calibrated instruments. The difference in reading from the sensor and the calibrated instrument were recorded and graphed. Linear regression of the sensor reading and the calibrated instruments was obtained. The equation from the linear regression was inputted into the program for the water temperature sensor.

E. Final Testing

The reservoir temperature was monitored every day based on their response to the whole system. Automatic turning on of the device when the parameters are beyond the threshold range, response time of the device to be able to attain the threshold range, and automatic turning off of the devices when threshold range is attained were among the data gathered and recorded.

F. Lettuce Production

The leafy variety of lettuce (*Lollo rossa*) was used as planting material in the automated hydroponics system as this is commonly used as planting material in hydroponics system. Media composed of carbonized rice hull, sand and rice hull was used as planting media in the automated hydroponics system since these contain most nutrients needed by the plants. The planting cups containing 2-3 lettuce seeds were placed in cups. The cups were placed on individual cut-outs of the growing tubes. The net cups should touch the flowing water in the growing tubes to avoid the plants to be dehydrated. The pump continuously lifts the water and nutrient solution allowing the roots to avail of the nutrients. The reservoir temperature level of the nutrient solution was maintained at a range of 24ºC - 30ºC level which is the recommended reservoir temperature level for lettuce production under hydroponics system. At this reservoir temperature level, the needed nutrients were made available to the lettuce plants. These parameters were maintained throughout the growing stage until harvesting stage of the lettuce. The lettuce was harvested 27 days after planting.

G. Validation

Validation refers to the process of checking that a system meets the specifications and that it fulfils its intended purpose. In the automated hydroponics system, the data gathered from the final testing was analysed and graphed. The automation system was modified to optimize the production system based on the data gathered. Another growing cycle of the lettuce was planted in the automated hydroponics system. Response of the system was monitored from planting to harvesting of the lettuce. The gathered data during validation was compared from the gathered data from the final testing. The differences from the two growing cycle and their relationship was obtained.

III. RESULTS AND DISCUSSION

The microcontroller used in the automated hydroponics system is Arduino Mega 2560 which served as the brain of the system and served as the trigger. It also processes the sensor data. Most of the parts were connected to the Arduino using simple jumper wires and the wires were soldered to ensure that they would not get loose. All of the electronic parts were then placed into plastic enclosure to protect delicate electronic parts from dust and moisture.

A. Installation of the Automated Reservoir Temperature Monitoring and Controlling System for Nutrient Solution

The microcontroller used in the automated hydroponics system is Arduino Mega 2560 which served as the brain of the system and served as the trigger. It also processes the sensor data. Most of the parts were connected to the Arduino using simple jumper wires and the wires were soldered to ensure that they would not get loose. All of the electronic parts were then placed into plastic enclosure (Figure 5) to protect delicate electronic parts from dust and moisture.

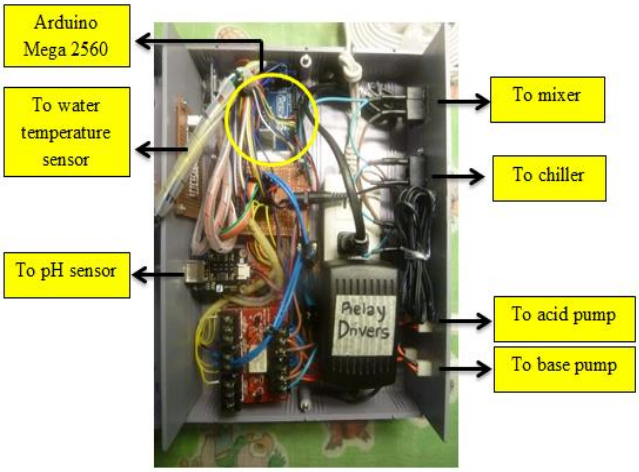

Figure 5. Electronic parts used in the automated hydroponic system

B. Water Temperature Sensor

The DS18B20 water temperature sensor shown in Figure 6 was used to determine the temperature of the reservoir in the hydroponics systems. The water temperature sensor was submerged to the reservoir and sends trigger signals to the microcontroller to activate the chiller thermostat and the mixer in the reservoir.

Figure 6. The water temperature sensor used in the study

C. Calibration of the pH Monitoring and Controlling System

Calibration of the reservoir temperature sensor used was done at the Center for Hydroponics and Aquaponics Technology in a 24-hour period before the data gathering. The reading from the sensor and calibrated instrument was obtained, recorded and graphed.

The graph of the calibration for the reservoir temperature sensor is shown in Figure 7. The graphs show linear relationship between the sensor reading and the instrument reading which also obtained an r^2 of 0.84. Based on the data gathered, the calibration equation for the reservoir temperature is $y = x + 0.37$. This equation was inputted in the program for the automation of the hydroponics system.

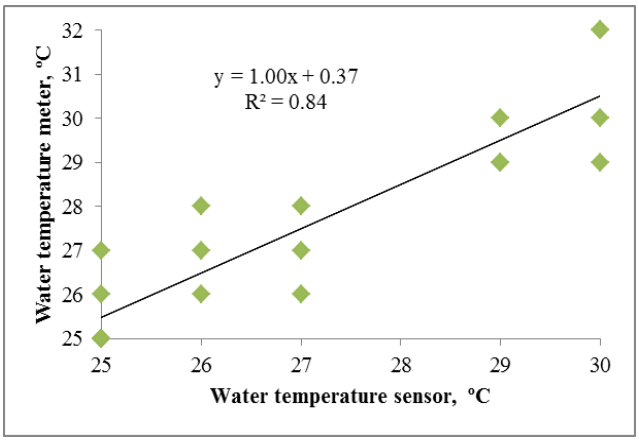

Figure 7. Calibration curve for water temperature sensor

D. Performance Evaluation

Based on the results, the obtained maximum reservoir temperature is 31ºC and minimum is 22ºC. The ability of the system to respond to the set threshold level, the response time of the system to the parameters, and the difference from the calibrated instrument were observed to be able to determine the reliability of the automated hydroponics system. Results showed that turning on of the chiller and mixer when the reading is beyond the threshold range is attained immediately after the reading is beyond the set value in the hydroponics system.

E. Validation of the Automated Reservoir Temperature Monitoring and Controlling System

During the validation period, the system was observed based on the criteria set for the reservoir temperature of the nutrient solution. Based on the results, the reservoir temperature reading and responses were accepted during the validation. Similar performance of the system during the validation and during the performance evaluation was observed. During the validation of the automated temperature monitoring and controlling system, the growth and number of leaves of the lettuce (test crop) were gathered and recorded weekly and the yield of the lettuce was obtained during harvesting. The lettuce crops obtained a total yield of 4.78 kg and an average of 20.6 grams per crop.

IV. CONCLUSIONS

Based on the objectives, the following conclusions were drawn:

1. the installed automated reservoir temperature controller was able to maintain the desired condition for the hydroponic system;
2. based on the observed successes and failures in monitoring the reservoir temperature, the performance of the developed automated reservoir temperature controller was found to be reliable, and;
3. the automated reservoir temperature controlling and monitoring device was able to grow lettuce with yield and responses similar to normal growing conditions.

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