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ADVANCING NATION FOOD SUPPLY THROUGH ACCELERATOR-DRIVEN TECHNOLOGY FOR CONTROLLED ENVIRONMENT AGRICULTURE

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***ABSTRACT** (Times News Roman, 12pt, Italic)*

Digital transformation can be obtained by the entry of the accelerator into the process, Siemens – Advanced Manufacturing Transformation Centre (AMTC) is one of the accelerators. It could enable firms to patent the technology and explore new concepts while developing ingenious solutions and driving business development. The client gets to see how the real and digital worlds enable one to design and facilitate a realization of the value chain as an end-to-end process optimized by a perpetuating data flow using the digital twin concept. This is happening in the Artisan Green activity, using the digital twin, they can create uncertainty in their product harvest to become more certainty. Artisan Green successfully implemented Controlled Environment Agriculture (CEA) and worked in cooperation with Siemens. The collaboration is to improve hydroponic operations by connecting an improved Farm Management System via Siemens' technologies to create parameters for another rack adoption based on the problem that is solved by the integrated system. It aims to achieve the next level of hi-tech, environmentally friendly hydroponic farming and tripling energy, yield, and recycling production rates. The centralized and vertical farming system implemented at Artisan Green ensures that land is used to optimum potential and thus increases the productivity of the farms, cutting on the use of pesticides and herbicides, this is a suitable method for Singapore. This paper explains more about the objectives of digital transformation, the process model, the difficulties, and finally the phase beyond disruption using observation and literature review method.

Keywords: *Digital Transformation; Disruptive Era; AMTC; Accelerator; Agri-tech Startup*

1. Introduction

The global disruption of the market has become a strategic need for all industries to adopt digital disruption to serve the market needs effectively and be competitive. Digital transformation means the use of digital technologies into an organization's activities and business models causing organizational change to how businesses work and produce and offer value. This change is due to factors such as shifts in technology, market forces, geo-political scenarios, and environmental issues that force changes to occur frequently. To encourage this transition effectively, ventures may often need the additional support that accelerators can offer in terms of frameworks, resources, and experience that can help them to innovate and expand.

The Siemens Advanced Manufacturing Transformation Centre (AMTC) is an example of such an accelerator; it supports organizations in experiencing this change. Thus, the AMTC offers a holistic setting for realizing Industry 4. 0 Vertical and horizontal integration of business processes, Integration of business processes. It provides scheduled training for line managers, coaching services, as well as early exposure and implementation assistance to trending technologies to assist businesses in their major change process.

Again, the AMTC's functions and services are not limited to merely providing the technology; it allows businesses to test new ideas and solutions and therefore serves as a platform of learning as well as spearheading concept development for growth.

Fundamentally, what AMTC provides to their clientele is know-how in the form of the Digital Enterprise Experience Center (DEX), which demonstrates to clients how the digital and the actual are not mutually exclusive. The DEX process helps firms create, simulate, and capture value chain improvements in one integrated graphical process, driven by a continuous feed of data. This integration also guarantees that companies can make the right information-based decisions in the shortest time possible and improve their processes and accomplishments of the principles of lean manufacturing. The integration of the electronic and the actual environment ensures that the measures are monitored, assessed, and adapted for real-time operations hence a competitive preparedness of firms in the industry.

A particular case that perfect example in displaying AMTC's effectiveness in driving digital transformation is the partnership with Artisan Green, a Singaporean hydroponic farming firm. Singapore being a city-state with poor usable land has faced a lot of difficulties in being able to produce its food. However, by adopting the best technology from Siemens, Artisan Green has operated CEA and has also been incorporating digital twin technology in their farming system. Easy integration of an upgraded FMS with Siemens' technologies enabled Artisan Green to build a new hydroponic racks system, which increased production rates and resource utilization. This has connections with some of the main principles of CEA, like environmental conditions management and resource utilization.

This partnership is a part of Singapore's "30 by 30 Express" strategy launched to raise the country's capability to produce 30% of food requirements by 2030. The initiative forms part of the Singapore Green Plan 2030 which aims at strengthening the food system under challenges likely to be posed by climate change, population growth, and increased demand for fresh and healthy food. Through the application of contemporary farming practices with the collaboration of Siemens company, Artisan Green has further increased its production ability in energy efficiency and limited the negative effects of its production in the environment making it a plus for progressive agriculture.

The objective of this paper is to discuss the goals and steps in digital transformation concerning the functions of accelerators such as AMTC in creating innovation and business improvements. It will highlight how data is processed or handled and look at how the relationship between the companies and the accelerators fosters co-creation, co-collaboration, and co-scalability of the market solutions. From the evaluation of the Artisan Green case, this paper will show how industries can be changed and developed sustainably through digital platforms and accelerators in the form of enhancing digitalization and automatization.

2. Literature Review

The Preparedness of Digital Transformation Process

The first and the main stage of the digital transformation process is the creation of a dynamic capability which is about developing digital competencies that will help the firm to adapt to new digital opportunities and threats and to evolve. This is the strategic renewal that is done to assist ventures in adopting new knowledge management practices and emerging applications such as mobile technologies, artificial intelligence, cloud computing, blockchain, Internet of Things (Warner & Wäger, 2019). Moreover, the venture must concentrate on digital technologies' application for changing capabilities, structures, processes, and business models. The organization not only promotes the new technologies but also integrates the organization processes to optimally use digital transformation (Nadkarni & Prügl, 2020).

From the corporate perspective, digital transformation is expected to achieve three chief levels, strategy, execution, and technology; this report is concerned with strategy execution and technology. A successful program should incorporate at least two of the above-mentioned levels of program, yet the best program will incorporate all three levels of programming done in a stepwise temporal manner. For instance, there is the coming up of a 'Digital' Business Model which if not supported by a new Go-to-Market strategy

remains purely an idea. On the other, the real new digitalization is to put in place digital instruments such as ERP or CRM, but not to move the Operating Model (Turchi, 2018).

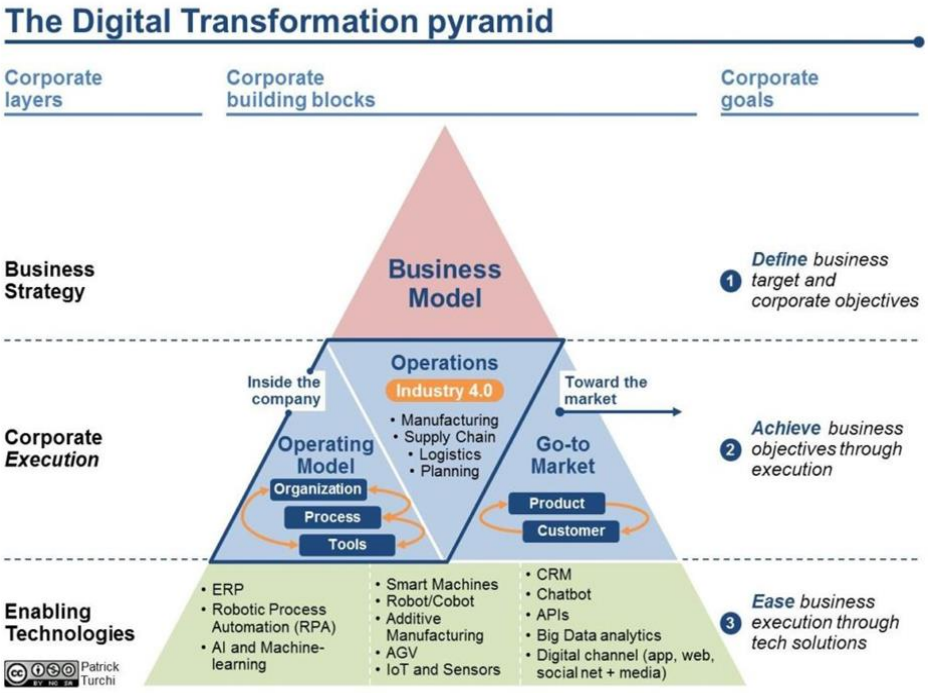

Figure 1. The Digital Transformation Pyramid
(Source: Turchi, 2018)

It is also important to note that one level of the framework engages or forms the others in the conceptualization of the framework. For this reason, such an approach needs to be global to embrace the strategic, implementation, and technology layers that must be synergistic. The framework has five components, as seen in the process descriptions above, Business model/strategy is in the Go-to-Market process, the operating model is under operations, technology is incorporated in both the Go-to-Market and operations, and lastly, the Go-to-Market is incorporated under operations. All these components must be integrated so that digital change efforts can occur and develop new forms of operations within an organization and in the market (Turchi, 2018).

Strategy (Business Model) is important and focuses on the evaluation of technology-based offerings such as the new platform players or data-based offerings. In this view, execution pertains to the concepts of turning the Corporate Operating Model, Operations Model, and the Go-to-Market strategy into operational physicalities of satisfying strategic directions. It is very important to emphasize that business transformation is not about application or a single technology, but applying applications and technologies to transform a business involves all the layers in the context of the business transformation pyramid. Since Digital Transformation is not a one-off process, the dependence on powerful change management is also constant. Finally, it relies on the people's openness to technology and better solutions in the organization (Turchi, 2018).

Digital maturity assessment is a requirement to define organizational position in their digital transformation process. The assessment should be incorporated and cyclical at the same time, which is why the principles of agility should be used to address the features of digital demands (Zaoui & Souissi, 2022). In addition, the development of digital dynamic capabilities must be the top strategic priority in the organizational context to enhance digital transformation performance; at the same time, organizational digital innovation orientation must be established. Thus, one can enhance the results of digital transformation through the

application of digital technologies, the increase of dynamic capabilities, and the development of a digital innovation culture (Lei et al., 2021).

The Stages of Digital Transformation

Based on the analysis, it is possible to point out that there are four distinct stages of digital transformation. The first stage of the model is digitized. Here technology is a tool for communicating and delivering the product or service to the customers. On the other hand, a range of activities is focused on the improvement of the communication channels and the digital marketing methods. In this case, technology plays a significant role in how a particular product gets to be known or disseminated, but the technology is relatively limited to the actual design of the product. For example, a company that has made a website to showcase its product or a business that has understood how digital marketing blends into the overall business strategy of the firm. In this case, this is the most obvious instance of the application of technology in a business model. So, there are no switching costs in the process of the value proposition creation; it differs only in the way it is communicated/shared (Cuofano, 2023).

The second one is the digitally enhanced stage. Technology is then the building block of the company's business strategy, and it defines the product or service that is offered making it valuable to the customers. Opinions that customers give in forums and other online publications are incorporated into the development of products. Digital defines the value creation and therefore the key elements of the business model of the company. In this case, technology is applied in the manner that the product is being developed or provided to the customer. Take for instance a firm that has established its e-commerce and distributes its products through it while learning how to assimilate customer feedback from the online platform into the design of the product. In other words, in this case, the technology factor has a greater impact on the product/service, thus enhancing its value to potential customers while at the same time providing a new product that meets customer preference/experience.

The worth model or the value proposition, mission, and vision, the technology model, or the Research & Development management, the distribution model, or the sales and marketing organizational structure, and the financial model, or the revenue modeling, cost structure, and profitability are the models that govern the business, and these are some of the models of a technology business. Collectively, the elements of a business model provide the basis for the creation of a successful technology business model (Cuofano, 2023).

The third stage is a platform-based one. The platform business model operates by generating value through the connection of all the players hence utilizing the concept of network effects. It means developing technology and business platforms through which people will be able to transact. The platform business model delivers value through the interactions of people, groups, and users leveraging on network effects. Platform business models generally consist of two sides, the demand and supply factors of a system are the rationale for the existence of this system. A two-sided market has a much broader platform to operate in a business model. Here, a company is on the top level It may be noted that the social media strategy is also on the apex level. This changed from merely promoting its products/services to creating the technical and business foundation wherein the two parties' interactions start (two-sided platform/marketplace/peer-to-peer) or more parties (multi-sided platform/marketplace) (Cuofano, 2023).

The fourth is the Business Ecosystem which is the network of businesses and their transactions with each other. In this stage, the technology forms a critical part of the value creation model. Knowledge management is emphasized from the non-technology system viewpoint, or the technology structure is aligned with the governance structure. However, successful development and growth of a community of developers and entrepreneurs is possible only if they implement the business platform. The bridge in this regard would be the technology and distribution at this level. That is right at a stage where a company has

transitioned to a place where the governance design is the issue, and the technology platform is aligned with it (Cuofano 2023).

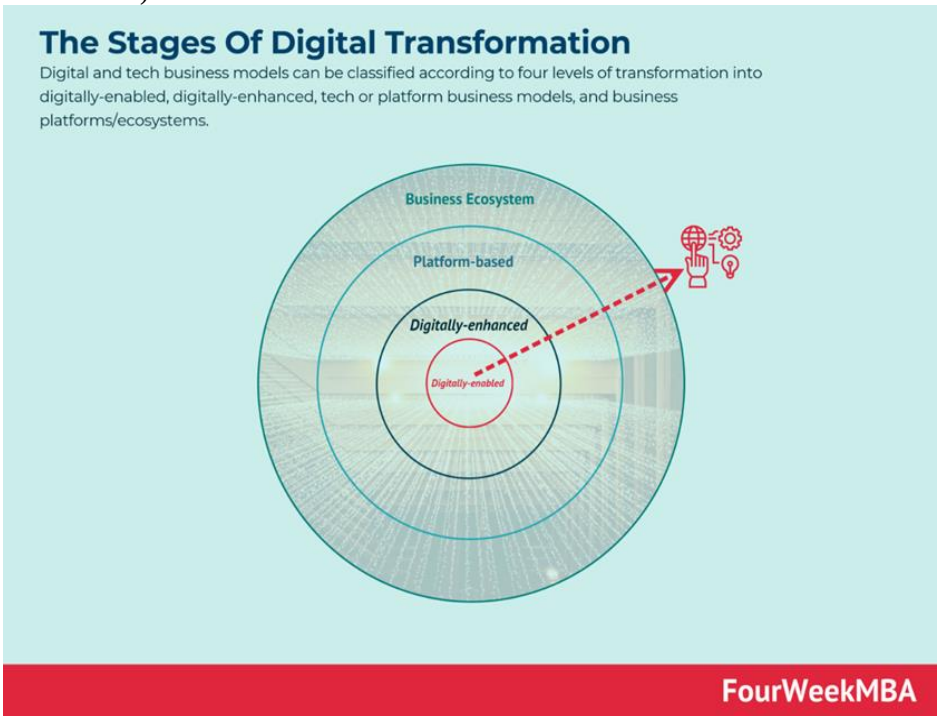

Figure 2. The Stages of Digital Transformation
(Source: Cuofano, 2023)

Contextual Framework

Digital transformation consists of a set of activities that an organization must undertake to make use of digital technologies to enhance operation, service, and, consequently, competitiveness. Annually, accelerators have been suggested as the ones that will be a necessity in the field of digital transformation. 'Technological enablers' in the digital transformation context are the gap between the current condition and the desired future state. They are the intermediaries, so they help the transition of processes, technologies, and people into a digitally enhanced condition. AMTC in the term refers to digital twin as one of the solutions offered in their services. This demonstrates why a company needs to have an accelerator that can help with planning necessary changes and their implementation effectively. In coordinating the initiative with the business strategies, accelerators can be of great assistance in the digital transformation process so that the transformation process is smooth and effective (Ananda, 2021).

This means while digital transformation includes the use of advanced technologies it is also a process that changes the organizational process. Here, it is possible to adjust the organizational processes with the help of an accelerator, learn new skills, and introduce digital technologies at the right time. The journey to embrace digital initiatives in an organization can be facilitated by an accelerator and there is always an assurance of creating a right fit between the organization and the new developments (Saraswati et al., 2022). In addition, the primary purpose of digital leadership in the era of digitalization, a means of positive digital leadership, can be the catalyst for change, guide innovation, and foster a digital mindset in the entire organization. They are the change makers that force the organization to adapt and go for digital technologies and practices in their entirety (Tulungen et al., 2022).

In addition, at present, the environment of digital ventures is such that partnering with ventures and large corporations can be very significant for the progress of innovation and digitalization in ventures. Such partnerships may provide ventures with the understanding, support, and access to the market to appropriately adopt Industry 4. 0 into their work. Through corporate partnerships, ventures can acquire the corporate knowledge and resources that are required in the process of passing through the activities in

digital transformation (Steiber, 2020).

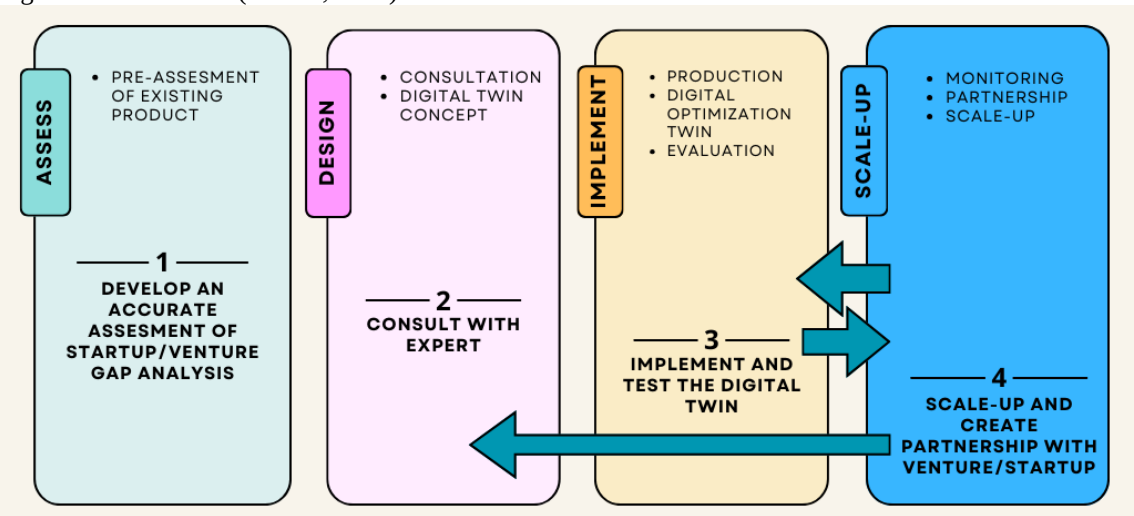

Figure 3. Contextual Framework
(Source: Researcher, 2024)

3. Research Method

Non-participant observation and a literature review were the methods chosen for this research to investigate digital transformation in manufacturing. Non-participant observation was applied as the researcher remained passive while observing the activities within the context of a digitally transformed manufacturing facility without having a direct influence on the participants. Using this method, it was possible to capture real behaviors, activities, and interactions between the employees and some sophisticated technologies that the company incorporated, including advanced automation systems and other digital twin technologies. Thus, the mere fact that the research was non-interventionist in that the researcher did not engage the participants in any activity helped avoid bias and other distortions that could have unpredictably altered participants' behavior within the observed environment.

In parallel, to situate these observations in the larger scheme of digital change and Industry 4.0, a systematic review of the relevant literature was performed. 4.0. Using the information obtained through the analysis of articles, reports, and case studies, the research established the theoretical background for the assessment of similar processes, the problems that firms encounter when trying to implement digital tools, and the assessment frameworks used in this connection. The literature review helped in understanding some concepts like; vertical and horizontal integration, digital twin technology, and lean manufacturing which were then used to analyze the behaviors and processes observed in the field.

Nonetheless, the combination of non-participant observation with a literature review made it possible to document the practical implementation of digital transformation and assess it based on theorization models. By integrating these three areas, a richer picture could be painted as to the role that digital integration plays in enhancing supply chain operations and generating new business value within the manufacturing industry.

4. Results and Discussion

The business environment is indeed quite dynamic, and it becomes very hard nowadays to carry out business in today's computerized economy. Of course, at this point, it is possible to state the fact that the further availability and efficiency of the proper use of digital services will determine the survivability and sustainability of the business initiatives. This suggests that many businesses are discovering that due to shifts in the predictability and stability of the business environment, several of them need to put in place preparations to change the fundamental business models through the digital business transformation strategy (Gupta & Bose, 2022).

Artisan Green is a market where it has been possible to emplace Controlled Environment Agriculture (CEA) successfully and has been in partnership with Siemens. It also improves the hydroponic operations by integrating an Integrated Farm Management System by employing Siemens technologies. This system relates to some principles of CEA including for instance the management of the environment as well as the prudent use of resources. This means, it is easy to move the technology from one rack of plants to a hundred racks of plants and therefore means conditions and parameters must change to meet the desired final product. This one change brought a very crucial agricultural revolution in Singapore as a nation that had no land for Agriculture but lacked some essential foods. It aims to advance to the second generation of hi-technology hydroponics with improved environmental sustainability, and at least three times the rate of increase in energy, yield, and recycling.

Technological intensive farming methods are faced with the following challenges: population increase and the resultant change in individual demand towards healthy foods, food scarcity due to climate change, and increase in farmland among others. Thus, Singapore has started large-scale efforts towards capacity-building of this segment to ensure that it can supply the country's food requirements naturally by the year 2030. This goal is also a part of the Singapore Green Plan 2030, for increasing the resilience of the food system. The "30 by 30 Express" is the S$30 million grant of the government that shows the government's stake towards local food production and hence an appropriate environment for such companies as Artisan Green is created.

As the company that Artisan Green has partnered with the company intends to advance the progression of sustainable food sectors in Singapore. Thus, applying this Siemens modern technology and experience in automation and digitization, Artisan Green can easily adapt its indoor farms to the modern integrated farm management system. They are creating an information cloud platform in the science of plants where vertical farming is applied; such a platform can help any vertical farmer in the world. Unfortunately, plant scientists can be expensive but necessary to foster this industry's development, meaning that it is crucial to leverage all plant science knowledge appropriately and, in turn, reach the multiplier effect.

Apart from environmental advantages such as growing food indoors, many advantages come with indoor farming as opposed to conventional farming. this makes farming centralized and vertical and hence utilizes the land to optimum and increases the productivity of the farms while at the same time reducing the usage of pesticides and herbicides. The tools result in better yields and quality of crops through managing hydroponic systems. It will also enhance the farming activities that are locally being undertaken due to the quality and productivity of the crops that will be produced when water and energy are well utilized.

This along with Siemens 'Precision Nutrient Injector project, a chilled water-cooling system, Siemens energy management software has enabled to bring energy consumptions, which are projected as 15 kWh per kilogram of produce, down to 50 percent below that, hence meeting and exceeding Singapore Food Agency Clean & Green Standards. All in all, their goal is to increase production quantity at a reduced operational cost, and they are more than willing to be the first and probably the best hydroponics farms and hi-tech farming that is not affected by weather conditions such as bad weather. This reliability of supply is important for Singapore's secured food supply to reduce the reliance on imports and build up its local production (Neo, 2023).

Integrated Farm Management System for Sustainable Farming

These are the foundations of this partnership as the intended goal is to utilize digital tools and automation to bring a level of accuracy to farming that is impossible with traditional methods of farming. This is in line with the emerging theme of 'smart farming' or 'Agriculture 4. 0' where most of the farming techniques rely on data-based decision-making and efficient use of gadgets and technologies such as sensors, artificial intelligence, and the Internet of Things in farming. (Hati & Singh, 2021).

Certainly, there are some of Siemens' cutting-edge technologies used in the Artisan Green unified digital platform, such as, the SIMATIC S7-1500 used for the optimal control of the process and growing parameters, SIMATIC ET 200SP with Dali module for the fine-tuning of the light intensity, an energy manager for the clarity and efficiency of the energy use, and WinCC V8 plus PM-Control to start developing a full farm management Together, the tools offer a command-and-control module that Artisan

Green uses to store and execute a variety of nutrient recipes and lighting profiles that are tailored to the plant's growth stages and calibrated for the plant's highest yield and best health. (Siemens, 2024)

The gathered data will be analyzed to become a web-based database of the diverse growth protocols of each crop to where the Farm Management System automatically runs the process to maintain consistency and record for every batch of crop grown; it will incorporate crop planning and scheduling to supply the fresh food on demand and at the same time efficiently utilize all the grow beds available. This also enhances input utilization effectiveness and reduces on effects of disease, pests, and unfavorable weather conditions. It was also possible to determine the right time to sell products and at the same time put seeds or cultivate crops through the aspects relating to the continuity and productivity of the farming practices. Hence, it is possible to indicate that the involvement of the ventures and the accelerator of digital transformation is necessary. Consequently, ventures can strengthen their current position on the digital business scene and get extra instruments and conditions, while the partners can receive advantages from the chance to learn from the ventures. The technological benefits that have been mentioned above due to the implementation of the digital twin, Artisan Green can predict and optimize production while not affected by climate and pests.

The Digital Transformation Pyramid of Artisan

Smart farming from the perspective of digital evolution means that there is progressive development of a high level of digitalisation through the decision-making level and the process chain up to the production systems. The first and, perhaps, the most important direction in the development of Artisan Green's digital presence is the integration and application of data analysis to guarantee that such moments as agronomy are sustainable and transparent. Through the data collected by the sensors of the state of plants as well as organisms, the information retrieved is processed systematically to offer the best conditions for crops. This sort of adaptation makes it possible to bring some standardization into the production process on the farm while at the same time increasing the operational effectiveness of the whole system. The interpretation of the findings is largely anchored regarding the concept of the digital transformation pyramid which is the visualization of Artisan Green Digital Transformation.

Another example is a high level of process automation due to the use of the unique Farm Management System, which proves the ability of Artisan Green to implement process automation. Some of the key farm activities like regulation of temperature, amount of light, watering, regulation of nutrients and light together with selection of the right recipes are all fully automated. Besides being helpful when it comes to the issue of accuracy in the use of the funds for a particular purpose, these are useful in that they reduce the interferences of people hence boosting productivity and at the same time reducing the rate of errors that may occur. Also, the technological integration in Artisan Green's operations is a good example of a high degree of digital integration. SIMATIC controllers with energy managers and superior control solutions such as WinCC V8 and PM-Control are some of the complete integrated solutions from Siemens. This in return allows swift and effective sharing of data and the comprehensive control of the environment of the farm which overall is highly digitized.

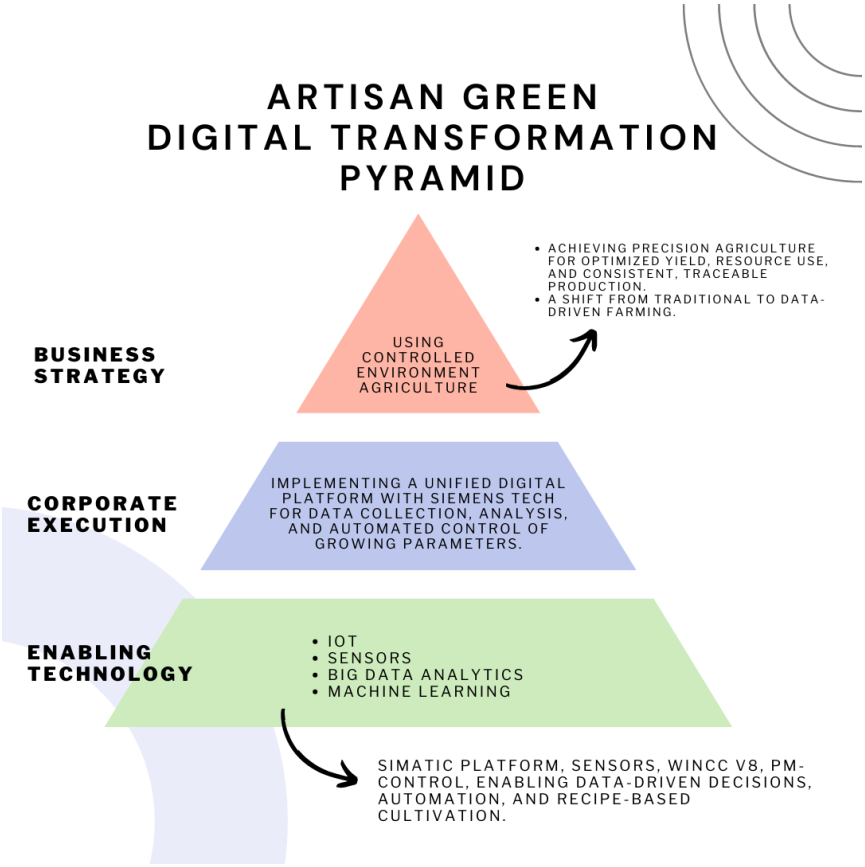

Figure 4. Artisan Green Digital Transformation Pyramid
(Source: Researcher, 2024)

Second, Artisan Green must acquire the skills that enable a firm to create and deploy dynamic resources effectively and efficiently in the context of digital farming. Heavily integrated sensor networks for continuous assessment of environmental status and resource consumption are used to form part of their data acquisition strategy. This real-time monitoring is quite useful in the aspect of 'seizing' opportunity through help from analysis of data to gain perception on factors that are essential to the plant yield optimization, better crop health as well and the right time to sell in the market. The ability to utilize resources is depicted in the transformation capability through the understanding that is embodied in the Farm Management System where an organization can establish and run its operations regardless of diseases, pests, and any other factors towards the maximum exploitation of the available resources to have the maximum production potential. These changes in the opportunities and threats indicate an active utilization of the tools for the stream of steady and diversified new forms of agriculture.

5. Conclusion and Implications

The Indonesian largest archipelagic country and the world's biggest agricultural produce will undergo a drastic change in the maritime and agriculture business when the shift to adopt emerging technologies and digital. Thus, the application of the Internet of Things, artificial intelligence, big data, and other advanced technologies will help Indonesia increase the effectiveness of the food sectors and ensure the sustainability of the environment and global competitiveness as well. Not only increase the export in the country but will also help to improve food security and efficient management of the marine resources which form the backbone of the Indonesian economy and the primary source of income for the nationals. For example, the

Internet of Things (IoT) is now employed in enhancing and coming up with better versions of the systems that are used in aquaculture such as the e-feeder systems from e-fishery.

These systems monitor and collect different sorts of data that significantly enhance fish farming processes; they are crucial for the digital transformation of fish farming. It is possible to program the e-feeders in a way that they feed at a specific time & the amount of feed that is dispensed during the feeding cycle is also captured. That information can help farmers change feeding frequencies and prevent them from providing more feeds to the algae in the fishpond. In addition, farmers are also able to know the state of health of the fish depending on the feed consumption daily and the feeding ratio that involves the feeding rate, growth of the fish, and the surrounding environment in which the fish are being reared.

Besides providing the fish food, the integrated IoT system can also control the water temperature, PH, dissolved oxygen levels, and Salinity to ensure that the water is most appropriate for the growth of the fish. Some of the elaborate systems have incorporated the use of cameras or sensors to study fish behaviors; important about feeding, and the farmer can know when the fish are under stress or disease IoT is part of the overall trend in the process of aquaculture where decisions are shifting from physical feel to the use of information. Thanks to IoT-obtained information, farmers can carry out more complex analyses, which can determine the efficacy of feeding, convert the mass of feed into the mass of fish, and reduce administrative costs while increasing production indicators in general.

Besides, there might be some issues, for instance, when a part of one of the IoT-based e-feeders is defective, or when there is an abnormal change, the user is alerted, and then proper action could be taken. This manner of processing real-time information makes it possible to smooth out digitally the industry of aquaculture, to make farming smarter. Everything mentioned above can be summarized in comprehensive reports and would constitute certain advantages for farmers, mainly in the field of making operation decisions, fish health improvement, or applying more sustainable approaches in aquaculture, which is highly valuable in terms of the constant automation of the sector.

Another implication which is also connected with Indonesia the integration of new technologies such as IoT, AI, and big data analysis into pest and disease could be a revolution for agricultural policy and food security at the national level. With these technologies, the government will be in a vantage position to track the different regions on the spread of pests and diseases. It means that this capability is useful in proactively planning how problems are going to be addressed and thus reducing the response that is always broad and unhelpful.

Secondly, information gathered from the sensors, images, and farmer reports can be analysed to identify trends and areas that require attention, and the government will be in a better position to give more focus to such regions. It also helps in the control of pests and diseases as it has to do with crop yields and supports the sustenance of agricultural systems by not using pesticides. In addition, this data can be used by the government to ‘capture’ the formation of policies and to encourage research & development as well as farmers’ knowledge and learning. Last of all, the use of these technologies is bound with the other goals of contemporary society including the necessity to develop the farming sector, feed the society, and make farming able to sustain its production considering climate change and other issues.

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