DIGITAL TRANSFORMATION MODEL FOCUSED ON PERUVIAN INDUSTRIAL FISHING

Pedro Martín Lezama Gonzales
National University Federico Villarreal, Lima, (Perú).
E-mail: plezama@unfv.edu.pe
ORCID: https://orcid.org/0000-0001-9693-0138

Ciro Rodriguez Rodriguez
National University Federico Villarreal, Lima, (Perú).
E-mail: crodriguez@unfv.edu.pe
ORCID: https://orcid.org/0000-0003-2112-1349

Francisco Manuel Hilario Falcón
National University Federico Villarreal, Lima, (Perú).
E-mail: fhilario@unfv.edu.pe
ORCID: https://orcid.org/0000-0003-3153-9343

Jorge Víctor Mayhuasca Guerra
National University Federico Villarreal, Lima, (Perú).
E-mail: jmayhuasca@unfv.edu.pe
ORCID: https://orcid.org/0000-0002-6465-4738

Recepción: 21/09/2021 **Aceptación:** 22/11/2021 **Publicación:** 14/02/2022

Citación sugerida:
Lezama, P. M., Rodriguez, C. R., Hilario, F. M., y Mayhuasca, J. V. (2022). Digital transformation model focused on Peruvian industrial fishing. *3C Tecnología. Glosas de innovación aplicadas a la pyme, Edición Especial,* (febrero 2022), 237-255. https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

ABSTRACT

The objectives of this research work were to determine the degree of improvement in the efficiency of the digital transformation, the efficiency in the extraction of fishing and the performance and the reference in the implementation of the digital transformation in the processes of extraction of fishing. A proposal for a model of digital transformation of processes was shown that helps in the improvement of the fishing production management process based on time, resources, profits and the collection of information on the entry and exit of the fisheries. Now they must be responsible for taking conditions at the time of carrying out the strategic method that will improve the production processes and be able to control the objectives based on bar charts. The development of technological change will allow monitoring alerts and obtaining control through devices within the reach of any responsible user. In summary, the results were the product of the comparative analysis of the last 4 years of fishing, due to the changes between fishing seasons

KEYWORDS

M-Learning, Digital Transformation Model, Operational Efficiency, Efficiency and yield of crops and references.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

1. INTRODUCTION

1.1. DESCRIPTION OF PROBLEM

The FAO in its latest report stresses that "society is faced with the enormous task of providing food and livelihoods for a population that will exceed 9 billion people by the middle of the 21st century, while at the same time solving the problem of the disproportionate effects of climate change and deterioration in the state of the environment as a resource base" (FAO, 2018).

Fish is the largest segment of the food market. "fish consumption accounts for 16% of the total amount of animal protein consumed in the world.", (FAO, 2018). This assessment of the global fish market is provided by Jürgen Vogele, director of the World Bank's Agriculture and Ecological Services Department.

Industrial fishing despite COVID 19, contributed 1.5% of GDP in 2020, Fishing industries manage their processes using SAP as the main ERP, however, the extraction process is controlled through customized developments (web and mobile applications), having a delay in data integration, and therefore in decision making.

These industries also do not have an end-to-end management of the extraction process, they only focus on complying with the quotas granted by PRODUCE (Peruvian fishing regulator), sometimes causing overfishing and threatening fish stocks, especially anchoveta.

1.2. ADAPTING TO TECHNOLOGICAL CHANGE

Emerging technologies, leveraging the ubiquity of cell phones and tablets, cloud computing, blockchain, have the potential to contribute to data collection. Automating and empowering data processing and analysis, employing business intelligence and analytics tools facilitate the communication of results to relevant stakeholders (Mnatsakanyan & Kharin, 2021).

Technology can also be used to expand the distribution and accessibility of data to decision makers, enabling them to optimize fishing based on the best available information and transforming unidirectional flows of information (fleet to manager) into a collaborative and mutually beneficial cycle of data collection, synthesis and sharing.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

Adapting organizations from siloed organizational approaches to process-oriented, indicator-based management, agile and value-oriented approaches are objectives that have not yet been fully implemented in fishing companies.

The digital transformation allows a gradual change in fishing companies, allowing an effective use of new technologies and their progressive adaptation in the organization.

1.3. OBJECTIVES

- Determine the degree of improvement in operational efficiency (vessel use, fuel use, cycle time) by implementing digital transformation in harvesting processes.
- Determine the degree of improvement in harvesting efficiency (quota advancement, fish quality, quota compliance per fishing trip and per season) by implementing digital transformation in harvesting processes
- Determine the degree of improvement in performance and benchmark (top 6 industrial fishing companies) by implementing digital transformation in harvesting processes.

2. MATERIALS AND METHODS

In the research "Opportunities to improve fisheries management through innovative technology and advanced data systems" provides an overview of the current status and challenges of technologically advanced data systems in the fisheries extraction process, and proposes a solution to guide greater use of technology, with the aim of improving fisheries performance (Bradley *et al.*, 2019).

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

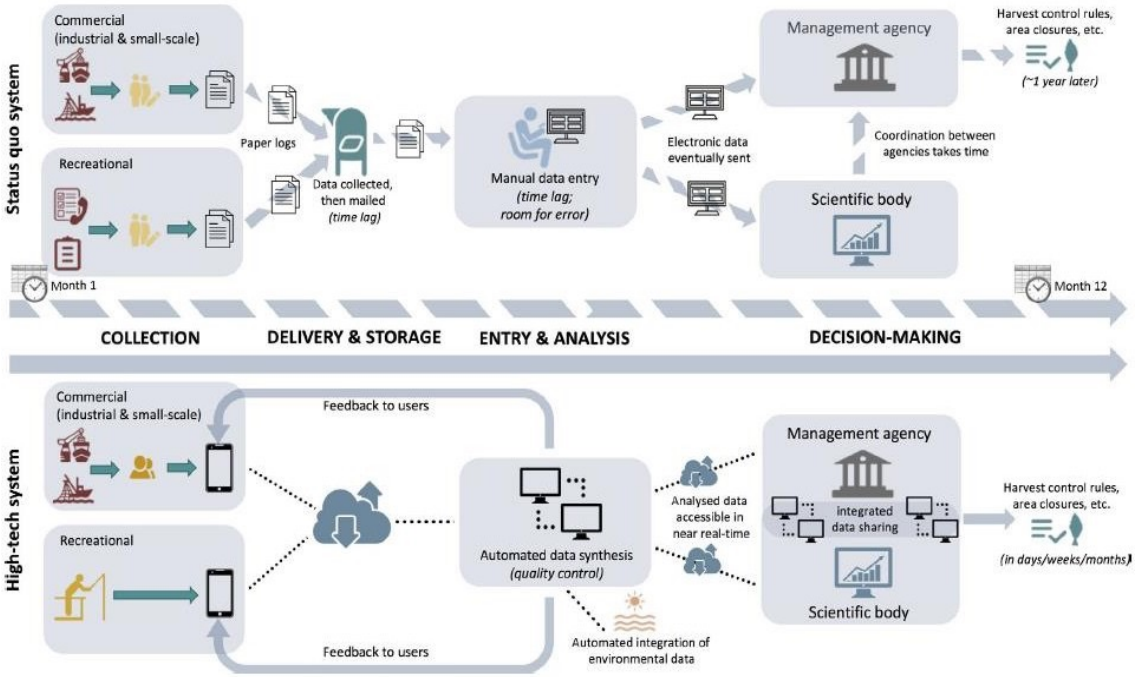

Figure 1. Conceptual diagram of fishery-dependent data collection systems using traditional systems (top) and the use of high technology (bottom).
Source: own elaboration.

2.1. PROPOSAL DEVELOPMENT

Next, we will show the conceptual diagram of the proposed digital transformation model based on the improvement of the management process by indicators.

a. Digital transformation model proposal

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

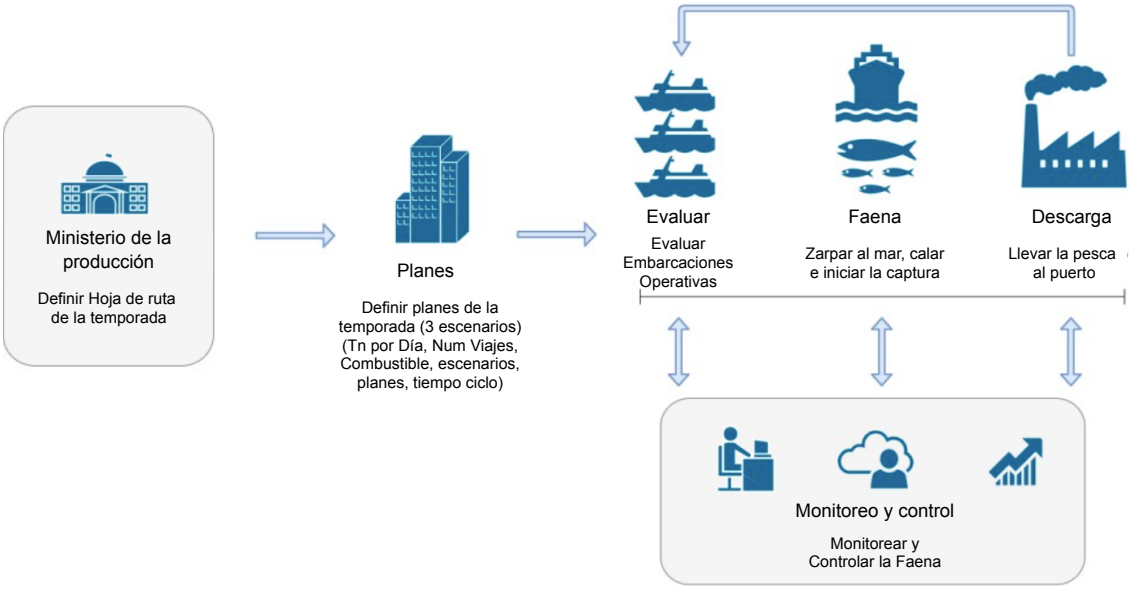

Figure 2. Proposal of the digital transformation model.
Source: own elaboration.

b. Description of the digital transformation model

The following table shows the respective summary of the digital transformation model:

Table 1. Responsibilities defined in the digital transformation model.

RE	EXTERNAL RESPONSIBLE. It is the maximum responsible for defining the terms of the fishing season. Includes authority and veto right.
RI	INTERNAL RESPONSIBLE. Responsible for defining the daily strategy that the organization will employ in the extraction of anchovy. (R)
MAC	MONITORING ALERT AND CONTROL. Is the maximum responsible in the control of the fulfillment of the goals and alerts the casuistry found every day in the different mobile devices, tablets, web applications and blockchain. (A)

Source: own elaboration.

Asks of the persons in charge

- **RE** is responsible for:
  - Evaluating whether the sea state is conducive for fishing.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

- Defining the date on which the two fishing seasons begin.
- Defining the number of days of operation.
- Defining fishing quotas.
- Define the size of the fishery.

- **RI** is responsible for:
  - Directing the evolutionary strategy of the daily fishing.
  - Carrying out fishing plans.
  - Carrying out fuel plans.
  - Making the fishing chronogram.
  - Define the sea route.
- **MAC** is responsible for:
  - Monitoring fuel consumption.
  - Monitoring the capacity of the vessel.
  - Monitoring the quality of the catch.
  - Alerting long unloading times.
  - Alerting long waiting times to set sail. o Alerting long waiting times to set sail o Alertinglong waiting times to set sail.

Detail of the tasks

Assessing the state of the sea

The Peruvian Ministry of Production carries out an evaluation of the state of the Peruvian sea and defines the areas reserved for artisanal and industrial fishing.

Define season start date

The Ministry of Production defines the start date of the season after the exploration of the Peruvian sea where it is verified that it is in conditions of exploitation. This procedure is carried out twice a year, in the Peruvian sea there are two extraction seasons.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

Define Quota and magnitude of fishing

The Ministry of Production defines the fishing magnitude after the evaluation of the Peruvian sea. This magnitude allows the rational exploitation of these hydrobiological resources.

Define days of operation

The ministry of production defines the days of the season allowing the rational exploitation of these hydrobiological resources.

Define evolutionary strategy

The organization defines a flexible evolutionary strategy for each fishing day because fishing is volatile. It takes into consideration the three fishing plans, fuel plans, vessel conditions, trip schedules, waiting times for unloading the catch, the time it takes to unload the catch, and the time it takes to wait before setting sail.

Define Fishing Plans

The organization defines three fishing plans, which allows you to visualize each day the status as the vessels report (favorable plan, intermediate plan, unfavorable plan).

Define Fuel Plans

The organization defines the fuel plans allowing you to make the plans flexible among the vessels according to their daily consumption and how much they have fished during the season.

Make the trip schedule

The organization defines the trips that the boats will make according to the weather, sea temperature and the fishing season they are in. To make the schedule more flexible due to navigation setbacks, GPS data is taken from the boats.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

Defining the maritime route

The organization defines the fishing route in the areas where the Ministry of Production allows it, taking into account historical data and experience of the fleet when defining the route where the anchoveta shoals are found.

Monitoring fuel consumption

The organization monitors the daily consumption of each vessel and the capacity of the vessel's hold. It analyzes fuel consumption per ton fished and distributes the information on the maritime route taken by the vessel so that the evolutionary fishing strategy can be redefined.

Monitor the vessel's hold capacity.

The organization monitors the free space of the vessel's hold, if the quantity fished is appropriate the RSW (refrigeration) is used due to the higher fuel consumption, but also ensures the quality of the anchoveta. Likewise, the sensors in the hold calculate the tons caught.

Monitoring the quality of the catch

The organization monitors the quality in which the anchoveta arrives at the port, dividing it into standard, prime and super prime. When a vessel arrives and fills more than 60% of its hold, it is decided to use the cold system (RSW) to maintain the highest quality.

Monitoring of fishing zones

The vessels have sensors, GPS and satellite communication, allowing to know the areas with schools of anchoveta, this allows to alert better fishing areas than those drawn at the beginning of the season in the schedule of trips, to comply with the fishing plan.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

Alerting of waiting time for unloading

The organization monitors the waiting times for unloading in the ports and can divert the unloading in another port if it is not favorable.

Alerting of unloading times

The organization monitors vessel unloading times, sensors in the port unloading area send an alert to the vessel when unloading is completed and the actual tons unloaded at the port is declared.

Alerting waiting times for departure

The organization monitors the time it takes for vessels to depart after anchovies have been unloaded.

Relationships of tasks and responsibilities

Table 2. Process tasks and their relationship to responsibilities.

PROCESS TASKS	RI	MAC
Define fishing plans in three tonnage scenarios	R/A	I
Define fuel consumption plans	R/A	I
Define the maritime fishing route	R/A	I
Make the fishing trip schedule	R/A	I
Monitor fuel consumption	I	R/A
Monitor vessel's hold capacity	I	R/A
Monitor the quality of the catch	I	R/A
Monitor fishing zones	I	R/A
Alerting long unloading times	I	R/A
Alerting long waiting times to set sail	I	R/A
Alerting long waiting times for unloading	I	R/A

Source: own elaboration.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

3. RESULTS

a) Fishing extraction results for the last 4 years

The analysis is a comparison of the result of the last 4 years of fishing, due to the changes in the weather between the first and second fishing season, the analysis is divided in two: Season-I and Season-II of the last 4 years.

Progress of tons fished

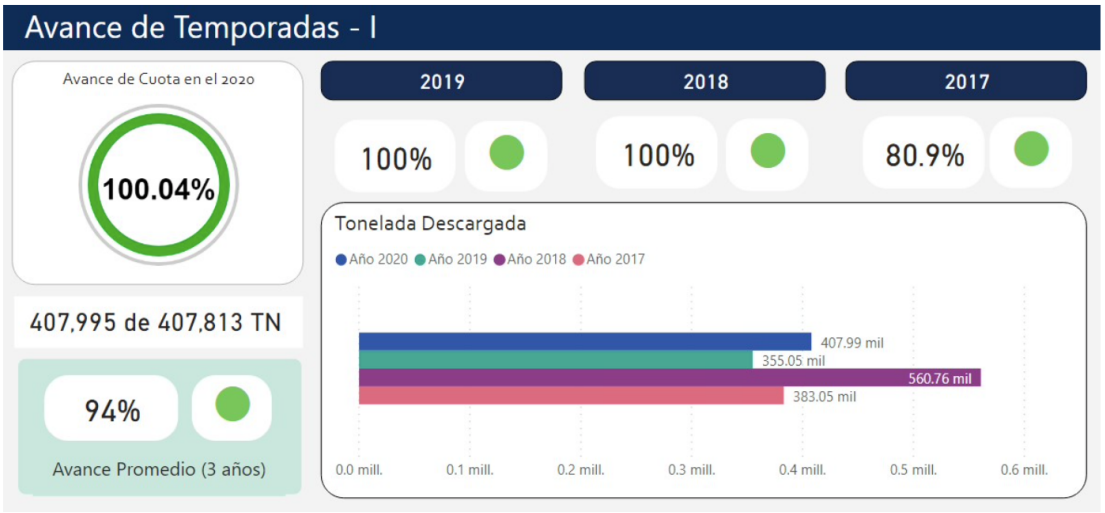

Figure 3. Tons fished advances.
Source: own elaboration.

According to Figure 3, the following was observed:

- In the last 4 years, the goal was reached with the exception of 2017, which only reached 80.9%, narrowly missing the minimum established of 80%. The traffic light for the years 2019, 2018 and 2017 is the comparison with the year 2020 and the average of the 3 years, which is in compliance with what was established.
- In the year 2020 it is observed how the target of 407,813TN (tons) was met and exceeded.
- The bar graph shows the amount of tons fished. Each year is different due to the quota assigned by the Peruvian Ministry of Production.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

Fuel consumption

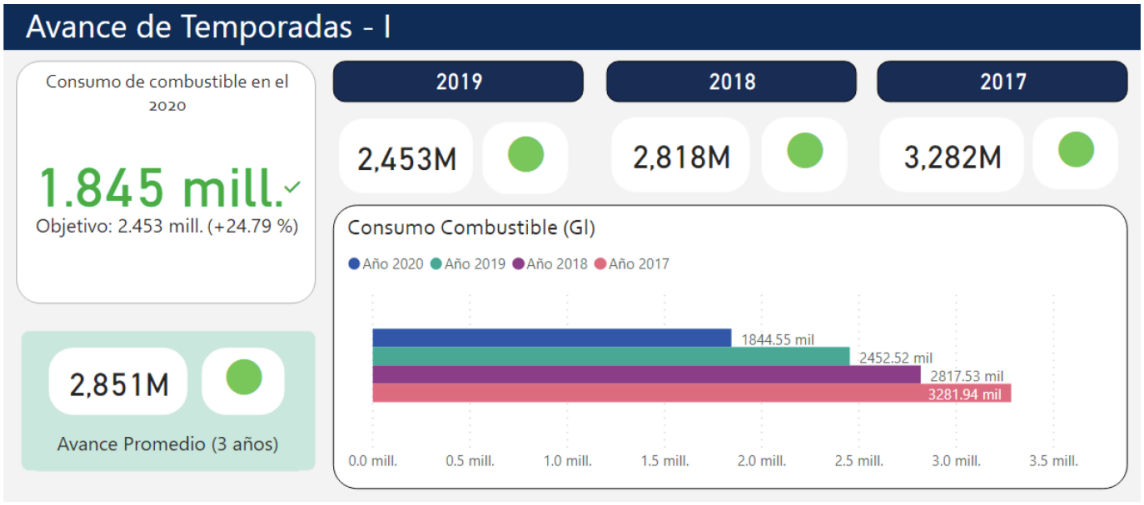

Figure 4. Fuel consumption.
Source: own elaboration.

Fuel consumption GL/TN

Figure 5. Fuel consumption GL/TN.
Source: own elaboration.

According to Figure 4 and Figure 5, the following was observed:

- Fuel consumption in 2020 is 1.845 million gallons, which is below the consumption of previous years; however, fuel consumption is linked to the quota that the company must fish, which can be seen in the advance graph of tons fished.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

Advancement of vessel performance

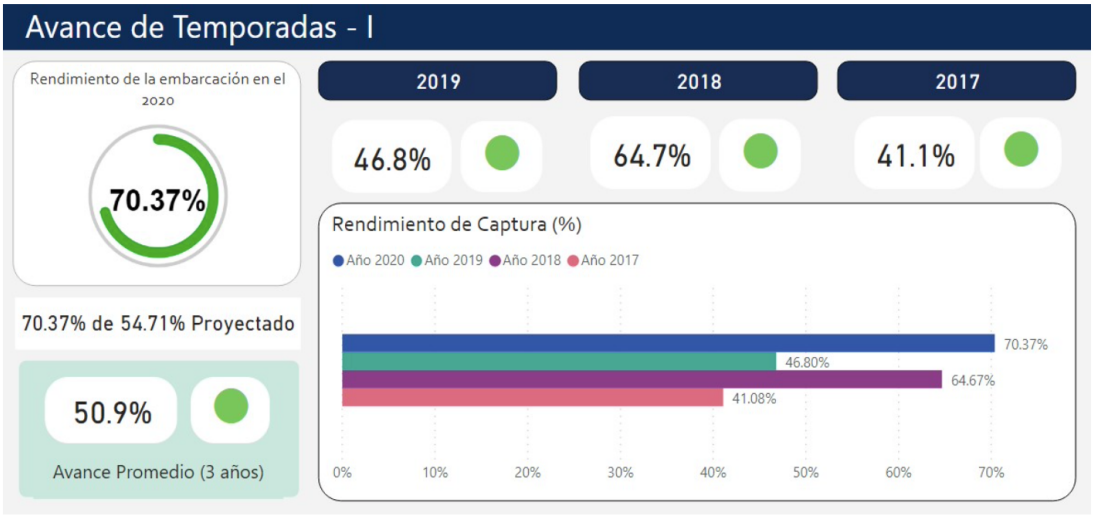

Figure 6. Advancement of vessel performance.
Source: own elaboration.

According to Figure 6, the following was observed:

- Increasing performance in 2020 compared to previous years.

Analysis by vessel size

The last 5 years of the fishing season-I are observed.

TEMPORADA_REGION	Tiempo de ciclo	Numero de Viajes	Capacidad de Bodega	Cantidad consumida de combustible	Toneladas pescadas	%Avance de la temporada	%Rendimiento	Consumo de combustible (GL/H)	Consumo de combustible (GL/TN)
Temporada 2020-I-Norte	**32.50**	**1541**	**579,795.00**	**1,844,554.00**	**407,994.50**	**100.04 %**	**70.37 %**	**51.27**	**4.52**
Flota Grande	39.13	217	122,210.00	462,601.00	93,805.22	109.54 %	76.76 %	76.97	4.93
Flota Mediana	31.09	1046	380,880.00	1,107,376.00	257,138.36	104.31 %	67.51 %	47.57	4.31
Flota Pequeña	32.58	278	76,705.00	274,577.00	57,050.92	75.40 %	74.38 %	41.05	4.81
Temporada 2019-I-Norte	**35.38**	**2164**	**758,615.00**	**2,452,524.00**	**355,048.55**	**100.04 %**	**46.80 %**	**47.96**	**6.91**
Flota Grande	46.05	200	109,070.00	514,884.00	57,522.45	77.18 %	52.74 %	75.76	8.95
Flota Mediana	33.97	1399	502,950.00	1,444,556.00	228,729.11	106.62 %	45.48 %	46.13	6.32
Flota Pequeña	34.90	565	146,595.00	493,084.00	68,797.00	104.47 %	46.93 %	37.84	7.17
Temporada 2018-I-Norte	**33.00**	**2377**	**867,070.00**	**2,817,530.00**	**560,756.56**	**100.04 %**	**64.67 %**	**50.16**	**5.02**
Flota Grande	37.27	296	162,710.00	644,211.00	116,084.51	98.62 %	71.34 %	79.73	5.55
Flota Mediana	32.19	1539	561,640.00	1,700,942.00	355,702.15	104.98 %	63.33 %	47.88	4.78
Flota Pequeña	32.94	542	142,720.00	472,377.00	88,969.91	85.54 %	62.34 %	37.60	5.31
Temporada 2017-I-Norte	**36.28**	**2618**	**932,375.00**	**3,281,942.00**	**383,047.82**	**80.95 %**	**41.08 %**	**46.17**	**8.57**
Flota Grande	44.44	294	158,440.00	740,015.00	77,078.04	77.57 %	48.65 %	74.36	9.60
Flota Mediana	35.54	1695	609,580.00	1,963,371.00	237,197.80	82.92 %	38.91 %	43.63	8.28
Flota Pequeña	34.38	629	164,355.00	578,556.00	68,771.98	78.33 %	41.84 %	35.88	8.41
Temporada 2016-I-Norte	**98,512.99**	**996**	**352,985.00**	**1,467,076.00**	**142,993.34**	**48.08 %**	**40.51 %**	**41.92**	**10.26**
Flota Grande	103,151.25	109	57,150.00	337,194.00	30,632.37	47.95 %	53.60 %	69.15	11.01
Flota Mediana	104,499.28	665	238,080.00	883,653.00	89,262.71	50.09 %	37.49 %	38.85	9.90
Flota Pequeña	78,303.65	222	57,755.00	246,229.00	23,098.27	41.76 %	39.99 %	33.36	10.66

Figure 7. Report of the last 5 years of the fishing season-I.
Source: own elaboration.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

According to Figure 7, the results of the digital transformation are seen in 2020, we visualize a slight reduction in cycle time.

Tons fished for the season – II

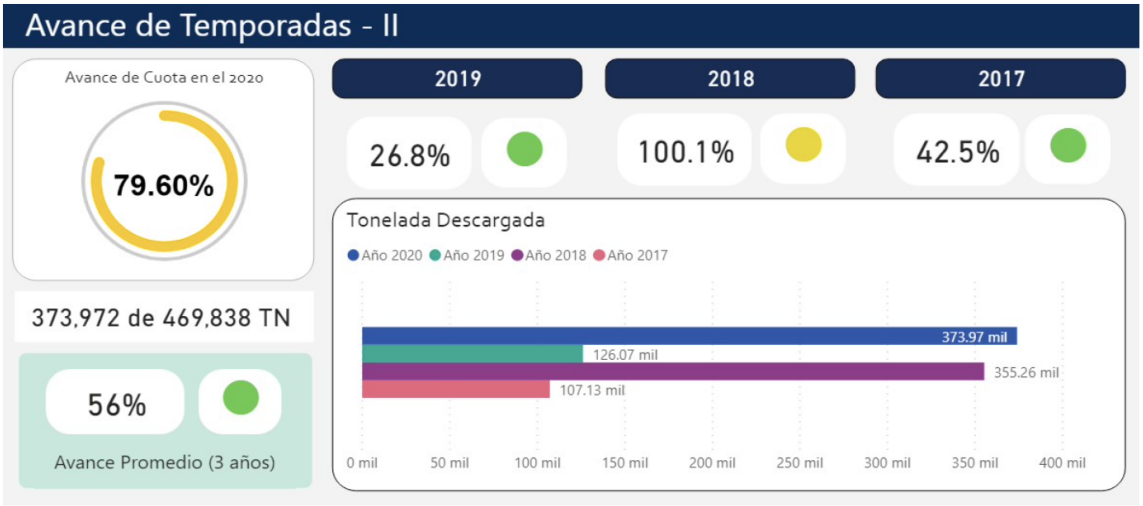

Figure 8. Season progress - II in tons of fish caught, own elaboration.

Advancement of vessel performance

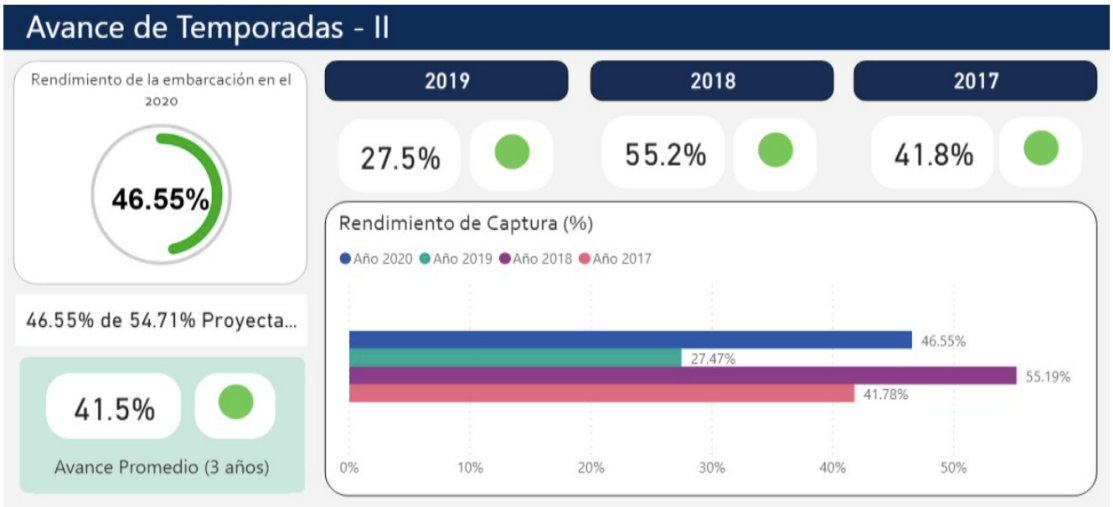

Figure 9. Vessel performance reportown elaboration.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

Fuel consumption

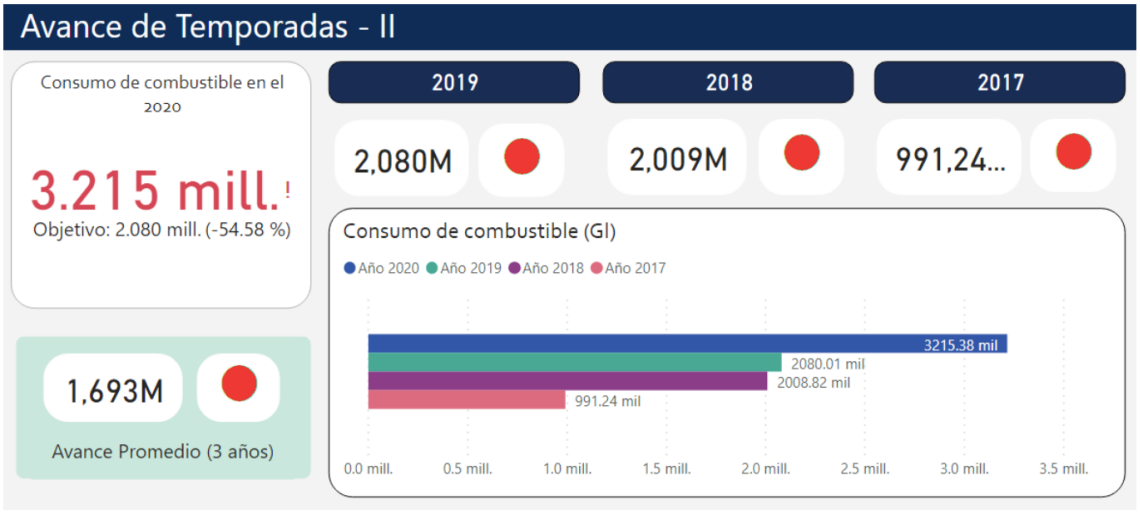

Figure 10. Fuel consumption report.
Source: own elaboration.

Fuel consumption GL/TN

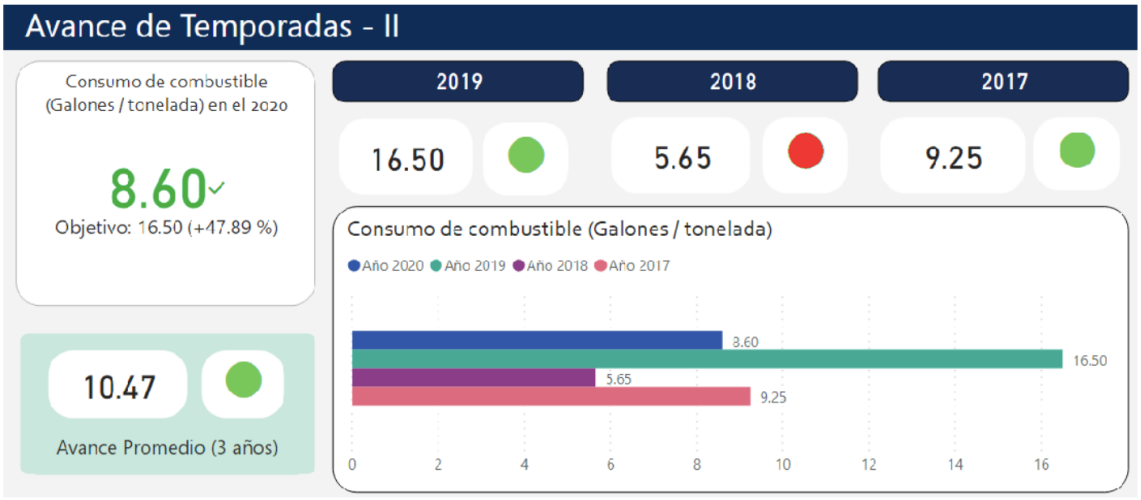

Figure 11. GL/TN Fuel Consumption Report.
Source: own elaboration.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

Analysis by vessel size

The last 5 years of the fishing season-II are observed.

TEMPORADA_REGION	Tiempo de ciclo	Numero de Viajes	Capacidad de Bodega	Cantidad consumida de combustible	Toneladas pescadas	%Avance de la temporada	%Rendimiento	Consumo de combustible (GL/H)	Consumo de combustible (GL/TN)
Temporada 2020-II-Norte	**35.19**	**2238**	**803,425.00**	**3,215,377.00**	**373,972.27**	**79.60 %**	**46.55 %**	**49.07**	**8.60**
Flota Grande	43.83	246	133,220.00	706,462.00	70,495.03	71.45 %	52.92 %	76.70	10.02
Flota Mediana	33.81	1469	531,820.00	1,938,664.00	230,045.37	81.00 %	43.26 %	47.31	8.43
Flota Pequeña	34.95	523	138,385.00	570,251.00	73,431.89	84.24 %	53.06 %	37.18	7.77
Temporada 2019-II-Norte	**39.81**	**1285**	**458,885.00**	**2,080,014.00**	**126,067.44**	**26.77 %**	**27.47 %**	**47.58**	**16.50**
Flota Grande	49.19	139	74,520.00	417,532.00	24,916.26	25.20 %	33.44 %	75.80	16.76
Flota Mediana	37.60	861	310,080.00	1,285,104.00	80,946.45	28.44 %	26.11 %	46.66	15.88
Flota Pequeña	41.86	285	74,285.00	377,378.00	20,204.73	23.13 %	27.20 %	35.38	18.68
Temporada 2018-II-Norte	**34.23**	**1812**	**643,690.00**	**2,008,818.00**	**355,260.56**	**99.95 %**	**55.19 %**	**44.05**	**5.65**
Flota Grande	48.49	214	116,980.00	490,468.00	71,200.45	95.54 %	60.87 %	58.60	6.89
Flota Mediana	32.82	1148	409,730.00	1,160,889.00	216,660.78	100.99 %	52.88 %	42.16	5.36
Flota Pequeña	30.97	450	116,980.00	357,461.00	67,399.33	101.54 %	57.62 %	36.88	5.30
Temporada 2017-II-Norte	**34.82**	**711**	**256,405.00**	**991,243.00**	**107,129.34**	**42.54 %**	**41.78 %**	**47.63**	**9.25**
Flota Grande	45.59	73	40,980.00	211,752.00	18,968.53	35.87 %	46.29 %	72.67	11.16
Flota Mediana	32.34	487	176,110.00	599,392.00	72,087.09	47.36 %	40.93 %	45.91	8.31
Flota Pequeña	37.51	151	39,315.00	180,099.00	16,073.73	34.40 %	40.88 %	37.21	11.20
Temporada 2016-II-Norte	**21,688.96**	**2272**	**811,260.00**	**3,071,178.00**	**326,083.77**	**98.68 %**	**40.19 %**	**47.09**	**9.42**
Flota Grande	4,210.22	246	132,210.00	668,592.00	63,059.16	88.85 %	47.70 %	76.10	10.60
Flota Mediana	21,388.94	1488	538,660.00	1,849,431.00	203,633.85	102.84 %	37.80 %	44.82	9.08
Flota Pequeña	30,510.80	538	140,390.00	553,155.00	59,390.76	96.65 %	42.30 %	36.47	9.31

Figure 12. Analysis report by vessel size.
Source: own elaboration.

Next, we are going to show the dictionary of key words regarding the fishing process:

- Cycle time: It is the average time it takes for a vessel, waiting in port, unloading the catch and the time it takes to set sail again.
- Number of trips: The number of trips made by the vessels as a whole.
- Hold capacity: The storage capacity of the vessels as a whole, expressed by the number of trips.
- Fuel consumption Gl/h: It is the fuel consumption per hour of the vessels.
- Fuel consumption Gl/TN: Fuel consumption per tons fished.

4. CONCLUSIONS

An improvement in operational efficiency was increased through the digital transformation in the collection processes, since it reached an increase in the last 4 years with a normal margin of 80.9%. In the year 2020 the objective was achieved and the margin of 407,813TN was exceeded. In addition, there is a bar system that shows the amount of catches obtained during the year, observing the development and progress of Peruvian productions.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

Harvesting efficiency was improved through the application of digital transformation in harvesting processes as there was moderate consumption with the bar platform evaluating the harvesting margin of fish for 4 to 5 years, achieving the objective as a point of improvement. within marine production.

A lower consumption of 1,845 million gallons could be obtained in reference to previous years due to the effectiveness of the platform that was able to evaluate the points in favor for production from the production analysis to the unloading times and waiting for delivery of the products. Sea products.

There was a total improvement in performance and reference based on the implementation of digital transformation in the collection processes with a margin of 70.37% in 2020- I, 46.55% in 2020- II, a higher rate than expected allowing invest in different resources that can help the production processes of the harvest based on different flexible techniques to be able to have fishing processes based: fuel, ship conditions, unloading time and sailing time, a lot of criteria must be considered in order to be able to have the highest effectiveness in the production method.

REFERENCES

Bradley, D., Merrifield, M., Miller, K. M., Lomonico, S., Wilson, J. R., & Gleason, M. G. (2019). Opportunities to improve fisheries management through innovative technology and advanced data systems. *Fish and Fisheries, 20*(3), 564-583. http://dx.doi.org/10.1111/faf.12361

Correa, J. I., & López, M. (2007). *Planeación estratégica de tecnologías de informáticas y sistemas de información*. Editorial Universidad de Caldas.

Falcón, J.C.B., Rodriguez, C.R., & Vargas, D.E. (2019). Real time facial expression recognition system based on deep learning. *International Journal of Recent Technology and Engineering (IJRTE), 8(2S11)*, p.4049. https://www.ijrte.org/wp-content/uploads/papers/v8i2S11/B15910982S1119.pdf

FAO. (2018). *El estado mundial de la pesca y la acuicultura.*

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

Hitpass. (2017). *BPM: Business Process Management: Fundamentos y Conceptos de Implementación*. BHH Ltda.-Santiago de Chile

Igarza, E. (2018). *Efectos de la Aplicación del M-Learning en el Desempeño Académico de los Estudiantes del Curso de Matemática de la Facultad de Ingeniería de Sistemas e Informática*. Universidad Nacional de San Martín-Tarapoto.

Levy, J., Pandey, B., Chowdhry, B., & Rodriguez, C. (2020). Prologue: Recent trends in computer science and engineering (RTCSE). *3C Tecnología. Glosas De Innovación Aplicadas a La Pyme*, 19-25. https://ojs.3ciencias.com/index.php/3ctecnologia/article/view/991

Luna, F. (2016). *Desarrollo web para dispositivos móviles: Herramientas para diseñar y programar WebApps*. Creative Andina Corp

Mnatsakanyan, A. G., & Kharin, A. G. (2021). Digitalization in the context of solving ecosystem problems in the fishing industry. *IOP Conference Series.Earth and Environmental Science, 689*(1). http://dx.doi.org/10.1088/1755-1315/689/1/012008

Otero, A. D. (2014). *Modelo de aprendizaje móvil abierto para educación superior.* Universidad Veracruzana. https://cdigital.uv.mx/handle/123456789/41450

Rodriguez, C., Lezama, P., Freddy, K., & Chavez, D. (2020). Bayesian model to determine genealogical links of family descendants. *Test Engineering and Management, 83*, 17937–17946.

Ubalde, R., Rodriguez, C., Petrlik, I., Esenarro, D., Lezama, P., & Sotomayor, J. (2020). Quality model for peruvian microenterprises of a software product factory. *Test Engineering and Management, 83*, 13434–13441.

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255

https://doi.org/10.17993/3ctecno.2022.specialissue9.237-255