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Lampiran Peer Review Korespondensi Proses Submit Publikasi Internasional
Judul Makalah: Fishermen behavior in the use of information and communication technologies (ICTs) in Central Java Province, Indonesia: Comparative study in Pati and Pemalang regencies
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Submission Letter
Submission of Manuscript Nugroho SBM

nugroho sumarjiyanto **<nugroho.sbm@gmail.com>** **Wed, Mar 3, 2021 at 5:10 PM**
To: zoobiomag2004@yahoo.com

Dear Editor in Chief AACL Bioflux

I am writing to submit our manuscript entitled Fisher Behaviour in the use of Information and Communication Technologies (ICTs) in Central Java Province-Indonesia: Comparative Study in Pati vs Pemalang Regency**, for consideration for publication in** AACL Bioflux.

I Hope this article can be published so that it can be used for my professors' submissions.

Thank you for receiving our manuscript and considering it for review. We appreciate your time and look forward to your

response.Best Regards,
Nugroho SBM

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Submission letter

Article title:
Fisher Behavior in the Use of Information and Communication Technologies (ICTs) in Central Java Province-Indonesia: Comparative Study in Pati vs Pemalang Regency

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Hereby I would like to submit the manuscript entitled "Fisher Behavior in the Use of Information and Communication Technologies (ICTs) in Central Java Province-Indonesia: Comparative Study in Pati vs Pemalang Regency**" to Aquaculture, Aquarium, Conservation & Legislation - International Journal of the Bioflux Society.**

This manuscript was not submitted or published to any other journal.

The authors declare that the manuscript is an original paper and contain no plagiarised text. All authors declare that they are not currently affiliated or sponsored by any organization with a direct economic interest in subject of the article. My co-authors have all contributed to this manuscript and approve of this submission.

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Date : 3 march 2021

Fisher Behavior in the Use of Information and Communication Technologies (ICTs) in Central Java Province-Indonesia: Comparative Study in Pati vs Pemalang Regency.

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Abstract**. The fourth industrial revolution requires the readiness in the use of information and communication technologies (ICTs) for fisheries and farming beside industrial sector. Moreover, climate change in the last decade leads to the development of technology to create tools in facilitating the convenience to head seaward. The tools do not rely on natural cues of fishing location at the sea because the fishermen awareness in the use of technology will be very helpful to improve fisheries products. This research combined quantitative and qualitative approach (mixed methods) as the research purposes were to compare fisheries awareness level in the use of ICTs in two potential fishing location in northern coastal area of Central Java, which were Pati and Pemalang regency.**

Results showed that fishermen awareness were quite high in the use of ICTs based on the two fishing location. The fishermen awareness in Pati regency were higher than Pemalang regency based on the fisher's age, while fisher awareness in Pemalang regency were higher than Pati regency based on fisher's level of education. Uncertainty income, the difficulty of internet coverage in the middle of the sea, and fisher's level of education became constraints in the use of ICTs in the fisheries sector. Accompaniment and modification in the application features will help to improve the use of ICTs in the fisheries sector.

Keywords**: small_scale, fishers, climate_change, ICTs, Pati-Pemalang**

Introduction**. Information and communication technologies (ICTs) in the field of fisheries were varied from the use of GPS, sonar, wireless devices, computers, internet and cellphones. ICTs are seen as being able to offer fisher's socio-economic improvement, simplify the communication process and increase fisher's safety (Omar et all, 2011). ICTs such as the Cloud, Internet of Things (IoT), location-based monitoring (remote sensing, geographic information, and drones), and Big Data will play a key role in achieving innovative food security in the context of the digital economy (El Bilali and Allahyari, 2018). The availability of information such as the distribution of fish catches, fishing gear used, and vessel size is required for proper management of plans in the management of capture fisheries businesses (Previero and Gasalla, 2018). Information regarding fish catchment areas will be very important to be applied to overcome the problems of seizing fish catchment areas and overfishing areas (Arifah, 2018; Simbolon et all, 2011).**

Despite having abundant fishery resources, the involvement of the community, especially fisher, will be very much needed in balancing the use and conservation of fishery resources (Suharno et all, 2017). Therefore, information in the form of a decision system is what is needed to support

fishing activities and ship operations. The rapid use of information and telecommunications technology can create cost efficiency in fisheries sectors (Arifah, 2018). Provision of appropriate information and technology will be of great benefit to fisher and entrepreneurs engaged in fishing. The price information of fishes is needed related to the fish price trading system, while information related to weather forecasts and sea wave information is needed by fisher because it is related to safety while sailing to the sea (Muawanah et all, 2018).

Climate change that occurs due to global warming is currently having an impact on the existence of traditional fisher who rely on natural cues to determine the location of their catch while at sea. Climate change makes the situation of fishery resources vulnerable and also makes fishers uncomfortable. Until now, many fishers haven't prepared climate change (Hartoko, A; *et al*, 2010). Low level of education, difficulty finding work, until a relatively old age are the reasons fishers continue to surviving as fishers (Tantra *et al.*, 2020). Therefore, the use of ICTs in the form of applications that can be used by fisher in fishing activities is very much needed. The use of information system applications for fisher will be related to fisher's awareness of ICTs. Therefore, the research aimed to: (1) analyze fisher's awareness in the use of ICTs in fisheries and 2) analyze the factors that support optimizing the use of ICTs in fisheries.

Material and Method

Study Sites. **Rudiawan et all (2012) states that the use of information systems can change the way fisher work from fishing to catching fish. The use of a technology system in the form of Potential Fishing Zone (PFZ) or *Zona Potensi Penangkapan Ikan* (ZPPI) maps must still be accompanied by training on how to read maps and navigation technology or GPS. Android-based information systems are very useful for fisher, both for the fishing process and for marketing their catch. As pointed out by (Chhachhar and Omar, 2012), fisher can get the latest information about the weather and can also save fisher's time by using cell phones. Mobile gives fisher the option to take a process to reduce risk, especially in emergencies when fisher are at sea.**

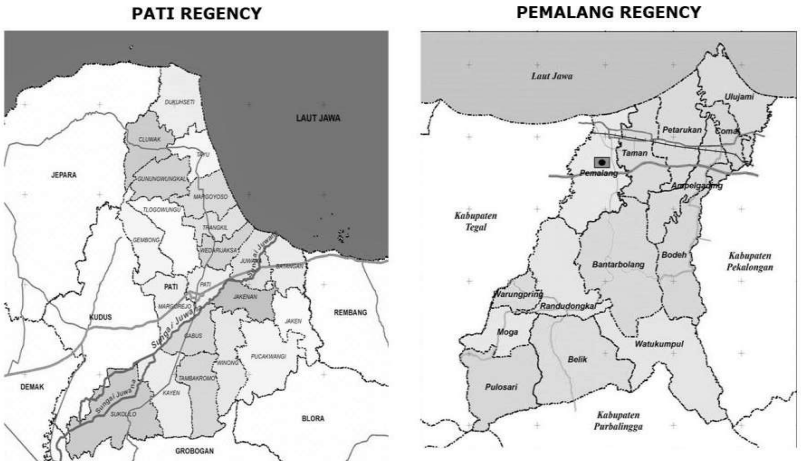


Figure 1. The Map of Study Sites in Pati and Pemalang Regency Central Java Province

This research took place in the northern coastal area of Central Java. Banyutowo village, Dukuhseti district, Pati regency and Asem Doyong village, Pemalang regency were selected as research locations. Pati and Pemalang regency were chosen because they are one of the pilot project areas for the application of the Fisheries Application from the Ministry of Fisheries and Marine Affairs based on the report of Marine and Fisheries Research and Human Resources Agency or *Badan Riset dan Sumber Daya Manusia Kelautan dan Perikanan* (BRSDM). Pati and Pemalang regencies are also potential fishing areas in Central Java. Even though the fisher in the fishing area in these regencies have used several technologies related to fishing techniques, they have not yet made use of the existing information system application. So that this area is used as a pilot area whose results can then be adopted by other fisher from other fishing regions.

Method. **The method used is a combination of quantitative analysis and qualitative analysis (mixed method) (Ardiansyah et all, 2019). Quantitative approach was done through descriptive statistics and qualitative approach was done throuogh simple triangulation with the help of Atlas.ti program. Respondents in this study consisted of 120 fisher of which 60 were from Pati regency and 60 were from Pemalang regency. Samples were taken based on 2 times the requirements for a small sample of 30 respondents. Respondents were interviewed using a structured questionnaire instrument in order to calculate quantitative analysis accompanied by in-depth interviews to obtain a clearer picture for qualitative analysis to support the research results. In-depth interviews were conducted with 12 key persons. Sampling of respondents was done by using purposive sampling method. Key persons in this study were elements of A-B-G-C which include academics, business people, the Fisheries and**

Marine Service of Pati and Pemalang Regencies, the Department of Marine Affairs and Fisheries of Central Java Province, as well as the Head of Fisher's Groups.

Results

Fisheries Characteristics. **Fisher in Banyutowo and Asemdoyong village were small-scale fishers based on the boat size with the average size of 10 Gross Ton (GT). This characteristic was related to the testing purposes of the Ministry of Fisheries and Marine Affairs stating that ICTs testing should be followed by only small-scale fishers, which were fishers with 10GT boats (Ministry of Fisheries and Marine Affairs go.id, 2019). The fisheries characteristics from respondents can be seen in Table 1.**

Table 1. Fisheries Characteristics

Variable		Pati Regency		Pemalang Regency	
		F	(%)	F	(%)
Boat Size (GT)	<5 GT	49	81.7	3	5.0
	5-10 GT	11	18.3	43	71.7
	>10 GT	0	0.0	14	23.3
Operational Trip Duration (days)	< 1 days	34	56.7	19	31.7
	1-3 days	15	25.0	33	55.0
	4-6 days	11	18.3	8	13.3
Fish Cathing Route (km)	0-2 km	9	15.0	6	10.0
	2-4 km	7	11.7	12	20.0
	5 – 12 km	27	45.0	33	55.0
	>12 km	17	10.2	9	15.0

Source: Primary Data (2020)

Table 1 shows the characteristics of fisheries in Banyutowo village, Pati regency and Asemdoyo village, Pemalang regency. Based on the boat size characteristic, the majority of fisher in Pati regency own boats with a size of less than 5GT as much as 81.7 percent, while the rest own boats with a size of 5-10GT. Meanwhile, the majority of fisher in Pemalang regency own boats with a size of 5-10GT (amounting to 71.7%), while the rest of fisher own boats with a size of more than 10GT (23.3%).

The length of the fisher's operational trip duration is calculated based on the number of days the fisher are at sea. The data shows that in both Pati and Pemalang Regencys, fisher have an average operational trip duration of 1 - 3 days. Operational trip duration is supported by the size of the fishing boat. Meanwhile, when the characteristic of fish catching route is compiled, fisher at both locations have a range of less than 12 miles. The bigger the size of the boat, the wider storage space and supplies so that the ship can travel longer and have a longer reach. On the other hand, a boat with a small size is only able to accommodate a limited number of supplies so that it will have limited operational time and a closer fishing range. The description of the fishing area for Pati and Pemalang Regencys is illustrated in Figure 2 as follows.

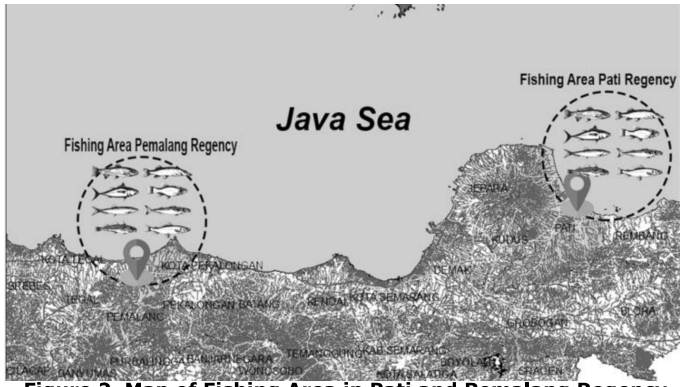


Figure 2. Map of Fishing Area in Pati and Pemalang Regency

Socio-Economics Characteristics of Fisher**. The socio-economics characteristics of fisher in Banyutowo village, Pati regency and Asemdoyo village, Pemalang regency are described in the variable of age, successful year, and income. Table 2 shows the socio-economics characteristics of respondents.**

Table 2. Socio-Economics Characteristics of Fisher

Variable		Pati Regency		Pemalang Regency	
		F	(%)	F	(%)
Age (years)	< 30	0	0.0	5	8.3
	30 – 40	21	35.0	28	46.7
	41 – 50	23	38.3	20	33.3

	>50	16	26.7	7	11.7
Successful Year*	0	1	1.7	5	8.3
	1-6	39	65.0	40	66.7
	7-9	10	16.7	12	20.0
	10-12	10	16.7	3	5.0
Income**	<12 USD	17	28.3	20	33.3
	12–14 USD	20	33.3	31	51.7
	>14USD	23	38.4	9	15.0

*Successful year represented the level of education of fisher
**Fisher's income/fishing trip in USD
Source: Primary Data (2020)

Table 2 shows a summary of the socio-economic characteristics of fisher at the research locations. The age range of respondents both in Pati regency and Pemalang regency was mostly between the ages of 30 to 50 years. This shows that fisher are at a productive age. The level of general knowledge of fisher is quite low, indicated by the 1-6 of successful year as much as 65 percent in Pati regency and 66.7 percent in Pemalang regency. This shows that fisher in the two study locations only completed basic education. Meanwhile, when viewed from the income of fisher, the results of the survey of respondents show that the highest income of fisher in Pati regency is 25 USD/trip, while the highest income of fisher in Pemalang regency is 32 USD/trip.

Fisher Awareness in the Use of Information and Communication Technologies (ICTs)**. ICTs in this study is the use of information from BMKG, GPS, Fish Finder, Television, and Windy application. The summary of fisher's perception toward ICTs of fisheries can be seen in Table 3 as follows.**

Table 3. Fisher's Perception in Fisheries Information

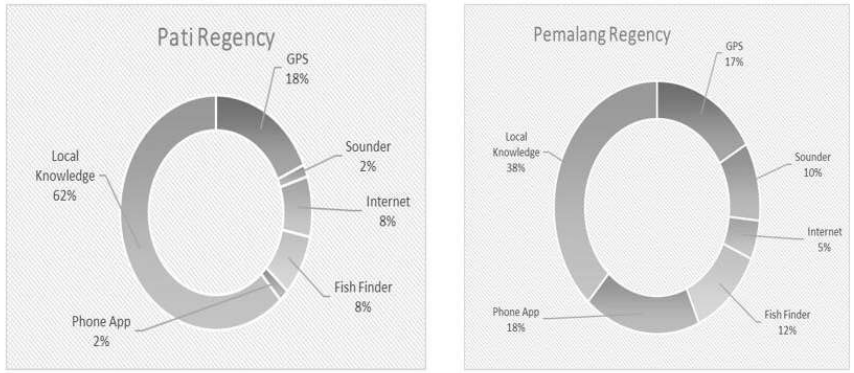
Indicator of Perception	Pati Regency		Pemalang Regency	
	F	(%)	F	(%)
Checking the condition of the sea weather and water information before going to the sea	33	82.5	54	90.0
Conformity of information with the real condition	33	82.5	40	66.7
The importance of fisheries information	38	95.0	52	86.7
The use of ICTs in fisheries	6	15.0	9	15.0
Constraints in the use of ICTs in fisheries	32	80.0	38	63.3

The pretension to access ICTs in fisheries	**30**	**75.0**	**44**	**73.3**
Mean	**71.7%**		**65.8%**	

Source: Primary Data (2020)

Table 3 shows the fisher's indicator of perception regarding fisheries information in Pati and Pemalang regency. The data shows that fisher in Pati and Pemalang Regencys have on average high perceptions of fisheries information. Based on the indicators, it can be seen that the fisher's perception of the importance of fisheries information in Pati regency has the highest percentage of perceptions, which is 95%. Meanwhile for Pemalang regency, the highest indicator is information of the state of the waters and sea weather before going to sea, which is 90%. Fisher awareness in the use of ICTs systems has the lowest percentage in both Pati and Pemalang Regencys. The information obtained also shows that fisher in the two research locations have quite high obstacles or constraints in the use of ICTs systems even though they have a high pretension to access the sea information from ICTs system.

Information related to the type of ICTs used by fisher in both research locations is described in Figure 3 as follows.



Source: Primary Data (2020)

Figure 3. ICTs Used by the Fisher When Sailing

Figure 3 shows the types of ICTs used by fisher when fishing. From the total respondents in Pati regency, 62% of fisher use the determination of fishing locations and information on weather conditions in the traditional way using natural cues. Meanwhile, respondents in Pemalang regency who still use natural cues or local knowledge is as much as 38%. This is due to the perception of fisher who state that natural cues can still describe weather conditions at sea. The use of traditional methods is still quite relevant to catching fish and other reasons are further explained

using triangulation analysis which is represented using the Atlas.Ti software. The traditional way to find information about servicing by reading natural cues was the most common practice among respondents both in Pati and Pemalang.

The analysis showed that 18% of respondents in Pati regency and 17% of respondents in Pemalang regency use GPS as a tool for fishing, 8% of respondents in Pati regency and 12% of respondents in Pemalang regency use fish finder, 2% of respondents in Pati regency and 10% respondents in Pemalang regency use sounder, and 8% of respondents in Pati regency and 5% of respondents in Pemalang regency have been looking for information on the internet based on data from BMKG. The use of ICTs system in the form of an android application is mostly used by respondents in Pemalang regency, namely as much as 18%, while in Pati Regency is only as much as 2%. From this information, it means that respondents in Pemalang regency are having higher digital literacy in technology than respondents in Pati regency.

Table 4. Crosstab of Age and Education to the Level of Awareness in the Use of ICTs

Variable		Level of Awareness							
		Pati Regency				Pemalang Regency			
		L	M	H	Total	L	M	H	Total
Age	**<30**	**0**	**0**	**0**	0	**0**	**2**	**3**	5
	30-40	**0**	**5**	**16**	21	**7**	**4**	**17**	28
	41-50	**4**	**5**	**14**	23	**6**	**3**	**11**	20
	>50	**6**	**5**	**5**	16	**5**	**2**	**0**	7
	Total	10	15	35	60	18	11	31	60
Education	**0**	**1**	**0**	**0**	1	**3**	**1**	**1**	5
	1-6	**8**	**14**	**17**	39	**6**	**10**	**23**	39
	7-9	**1**	**2**	**7**	10	**1**	**2**	**10**	13
	10-12	**0**	**3**	**7**	10	**0**	**0**	**3**	3
	Total	10	19	31	60	10	13	37	60

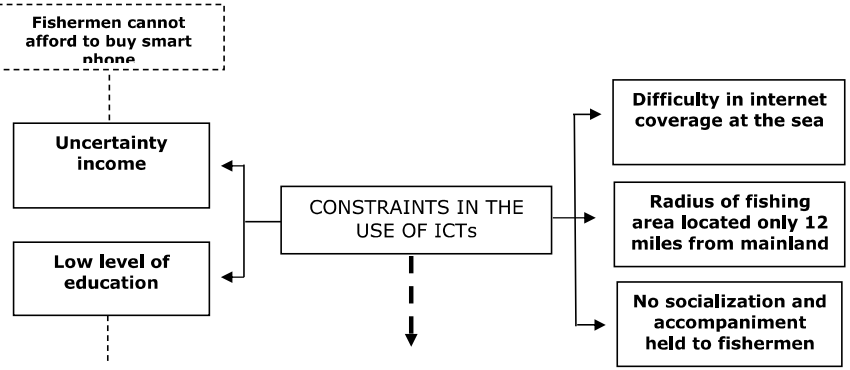
L: low; M: moderate; H: high

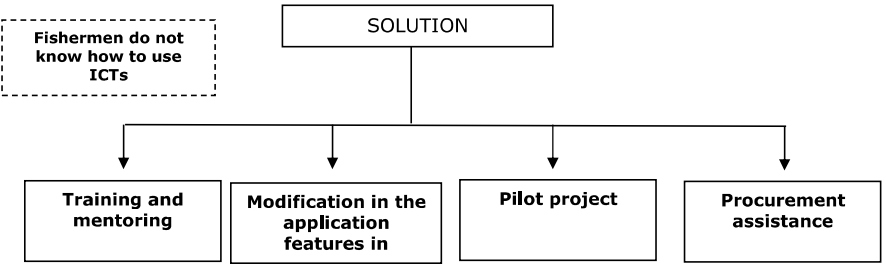
Source: Primary Data, Processed by SPSS (2020)

Table 4 shows the level of awareness of fisher in the use of ICTs in Pati and Pemalang. As many as 35 fisher in Pati regency and 31 fisher in Pemalang regency have a high level of awareness to use ICTs in terms of age. Whereas as many as 31 fisher in Pati regency and 37 fisher in Pemalang regency have a high level of awareness in using ICTs based on the level of education. It shows that most fisher care about the

importance of ICTs for fishing activities. The majority of respondents who had a low level of education turned out to have a high level of awareness of using ICTs in both Pati and Pemalang regency. It shows that the level of education of fisher should not be an obstacle or constraint in implementing the use of service ICTs. It only takes training and mentoring to achieve fourth industrial revolution in the fisheries sector.

Factors Supporting the Optimization in the Use of ICTs**. Based on the results of in-depth interviews, the constraints in using ICTs at the research locations are the uncertainty of income which causes the inability to buy smart phones or other supporting technology, inadequate socialization and mentoring, and low education. The last factor supporting causes respondents not to know how to use the existing ICTs. In addition, the radius of the fishing area which is only 10 miles from the mainland is also the reason fisher feel they do not need to use sophisticated technology. Besides, the internet coverage at the sea is quite low. Fisher stated that they had difficulty of internet access on the high seas. According to stakeholders, the strategy to optimize the use of ICTs is to organize a pilot area through mentoring and modification of features in the fisher's application, one of which is by adding features that can predict fish seasons. So that fisher can use fishing gear according to the season. An overview of optimizing the use of ICTs is summarized in Figure 4 as follows.**





Source: Primary Data, Processed by Atlas.TI (May 2020)

Figure 4. Optimization in the Use of ICTs in Fisheries

Discussion. **According to Sabu et all (2017), the adoption of ICTs system tools in the fisheries sector depends on several variables such as boat size, number of crew members, fisher education, area specifications, duration of days per trip (operational trip duration), and the distance of fishing grounds (fishing route). Figure 2 shows the results that fisher awareness about the use of ICTs applications for fisheries is quite high, as shown by the opinion of fisher about the importance of service information by 95%. However, about 85% of fisher have problems in the use ICTs application. The constraints experienced by fisher were put forward by Sugiono as the Head of the Fisher Group in Banyutowo village as stated:**

"Actually, fisher want to use the fisherman application. This application really helps us to know the accuracy of the weather or the high waves at the sea. It is very helpful for this kind of application, but the obstacle is that fisher are lazy to learn this kind of thing because it seems complicated. I myself am confused when holding a cellphone. Fisher here also don't have cellphones because it's expensive."

Before going to sea, fisher look for information about water conditions. The attempt is done to anticipate weather conditions when fishing so that it can increase safety when sailing. Fisher are a high-risk job that is highly dependent on natural conditions and the occurrence of climate variability problems can be in the form of shifts in rainfall, wave height, and wind speed which can affect fishing operations carried out by fisher (Azizi et all, 2017). Information about fish catchment areas is very important to be applied to overcome the problems of seizing fish catchment areas and overfishing (Muhsoni et all, 2009; Paul et all, 2016). The response of small-scale fisher to the existence of ICTs as shown in the study is still low where the use of traditional methods dominates fisher in helping fishing activities. Even though fisher are aware that information about fishing locations, weather change, and high sea waves is needed. The information technology referred to in this research is the use of information from BMKG, GPS, Fish Finder, Television, and Windy application. Factors supporting that affect fisheries production are season, weather, and technological advances such as the use of a global positioning system (GPS) as a direction and fish finder to detect fish (Sulastri, 2014). Other advances in information technology, such as information on fish prices in near-shore markets, will affect the stability of fisher's arrivals so that fisher are not disadvantaged (Foss and Couclelis, 2009).

The implementation of the fisheries information application requires a re-assessment, especially for fisher who are on the island of Java, where

there will be overfishing cases from time to time. It is related to the statement of Amperanto from Department of Fisheries and Marine Affairs in Central Java:
"Small-scale fisher have only 12 miles of fishing radius at the sea from mainland. If later some fisher find a fishing location at one point, they will gather in groups to catch at the same point, it will cause overfishing, making it more suitable for boats of more than 10 GT."
Another obstacle is that fisher do not have a definite or certain income, so they cannot afford to buy supporting equipment such as GPS or mobile phones to help activities when they go to the sea. Furthermore, the low level of education causes the fisher to not realize about the importance of supporting ICTs in order to increase fishery production. The fishing route is also a constraint as the small-scale fisher can only do fishing ini the radius of 12 miles from mainland. The fishing range also leads to difficult internet signal as the internet coverage in the middle of the sea is bad. Besides, there is a high risk of taking cellphones at the sea. Fisher tought that the cellphones damage is difficult to avoid, while the cost of getting cellphones is quite high. Recommendations for increasing the application of service information applications are suggested by providing assistance, mentoring, and modification of service application features that are more suitable for small-scale fisher. Things that need to be needed to overcome development problems in the fisheries value chain are technology adoption, government intervention, environmental awareness and fish farming organization *(Suharno, et al* 2017). It is in accordance with the statement of Rofik from the Marine Fisheries Office of Pati regency, PPP Bajomulyo Branch, which stated:
"The small-scale fisher do not only use one type of fishing gear. The different season requires the different fishing gears because the kind of fishes will also be different. This application should be complete with weather information and notifications so that fisher can predict what kind of fishing gears they have to use in certain season."
Feature adjustments in the fisheries application are needed because traditional fisher are still confident enough to continue using traditional event modes or natural cues because fisher also quickly follow changes in nature overseas, although this estimate is not accurate in practice.

Conclusion. **The use of ICTs is now something that can no longer be avoided. Based on the results of the analysis and discussion, it can be concluded that the level of awareness of fisher in Pati regency is higher than Pemalang regency in terms of age. Whereas the level of awareness of fisher in Pemalang regency is higher than Pati regency in the level of education. Fisher in the two research locations have a high awareness of the importance and usefulness of ICTs in assisting fishing activities. Even so, the use of information technology has not been widely used. Capital for technology purchases and fisher's reluctance to study technology are constraints that are still not optimal in the use of ICTs system in the fisheries sector, especially in the northern coastal areas of Central Java.**

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Initial Evaluation Before Review

AACL Bioflux - manuscript reception confirmation

Tudor Papuc <ptudor2008@yahoo.com> Thu, Mar 4, 2021 at 7:34 PM
Reply-To: Tudor Papuc <ptudor2008@yahoo.com>
To: "Nugroho.sbm@gmail.com" <Nugroho.sbm@gmail.com>

Dear Dr. Nugroho,
This is a message of confirmation regarding the reception of your manuscript Fisher Behavior in the Use of Information and Communication Technologies (ICTs) in Central Java Province-Indonesia: Comparative Study in Pati vs Pemalang Regency**, submitted to our journal AACL Bioflux.I will soon contact you with further information regarding your manuscript.**

If you can, please recommend 1 or 2 reviewers for your manuscript. It would probably go faster this way. If you cannot, there is no problem, I will search for reviewers.
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Please try to keep one message thread (respond/ask with "Reply") for an easier message management. Thank you for considering our journal.

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Hello, the paper is at one reviewer at this point, and I am searching for the second one. Most likely, the paper will be preliminary accepted (very high chances). I will try to send you the payment details and official preliminary acceptance letterin about a week (when there will be at least one positive review).

Best Regards,
Tudor Păpuc Editor,
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Publication Payment

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nugroho sumarjiyanto **<nugroho.sbm@gmail.com>** **Mon, Apr 26, 2021 at 7:45 AM**
To: Tudor Papuc

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I Hereby send proof of payment via bank transfer for publication fees. Thank you.

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Tudor Papuc **<ptudor2008@yahoo.com>** **Tue, May 4, 2021 at 3:16 PM**
Reply-To: Tudor Papuc <ptudor2008@yahoo.com>
To: nugroho sumarjiyanto
<nugroho.sbm@gmail.com>

The payment was confirmed. Please find attached the invoice for the payment you made. No other updates yet.

Best
Regards,
Tudor Păpuc
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Asking about the publication of manuscript

nugroho sumarjiyanto **<nugroho.sbm@gmail.com>** **Thu, Jun 10, 2021 at 6:50 PM**
To: Tudor Papuc

<ptudor2008@yahoo.com>To: Mr Tudoc

Papuc

Dear sirs,

I would like to ask politely about when will my manuscript be published on Bioflux.Thank you.

Sincerely yours
Dr. Nugroho SBM

Gmail nugroho sumarjiyanto <nugroho.sbm@gmail.com>

Publisher Responses #1
Asking about the publication of manuscript

Tudor Papuc **<ptudor2008@yahoo.com>** **Sun, Jun 13, 2021 at 3:00 AM**
Reply-To: Tudor Papuc <ptudor2008@yahoo.com>
To: nugroho sumarjiyanto
<nugroho.sbm@gmail.com>

Hello, there is one positive review, and the second evaluation is not yet finished.
After the evaluation will be finished, there will be a period of 2-3 weeks in which I will correct the English, check the formatting and add the reviewers comments to the paper.
So, if everything goes ok, the paper will probably be published at the end of July or in August.

Best
Regards,
Tudor Păpuc
Editor,
Bioflux

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Gmail nugroho sumarjiyanto <nugroho.sbm@gmail.com>

Gently asking about my manuscript#2
Asking about my manuscript

nugroho sumarjiyanto **<nugroho.sbm@gmail.com>** **Thu, Jul 15, 2021 at 6:49 PM**
To: Tudor Papuc <ptudor2008@yahoo.com>

To Mr Tudor
PapucEditor of
Bioflux

Dear Sirs,
I am so sorry. Once again, I would like politely ask about my manuscript if it has been corrected by second reviewer and when will it be published. Thank you.

Sincerely Yours,
Dr. Nugroho Sumarjitanto BM, MSi

Gmail nugroho sumarjiyanto <nugroho.sbm@gmail.com>

Publisher Responses #2
Asking about my manuscript

Tudor Papuc **<ptudor2008@yahoo.com>** **Mon, Jul 19, 2021 at 10:36 PM**
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To: nugroho sumarjiyanto
<nugroho.sbm@gmail.com>

Hello,

Both reviews are positive. I will try to send you the paper by 2 August, and publish it later in

August.Best Regards,
Tudor Păpuc
Editor, Bioflux

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Gently asking about my manuscript#3
Gently asking about my manuscript

nugroho sumarjiyanto **<nugroho.sbm@gmail.com>** **Thu, Aug 5, 2021 at 9:24 PM**
To: Tudor Papuc <ptudor2008@yahoo.com>

to: Mr Tudor
PapucEditor of
Bioflux

Dear sirs,
I am sorry to disturb you again. Politely I asked about my manuscript, how are reviews from the reviewers and when can it be published. Thank you.

Sincerely yours
Dr Nugroho Sumarjiyanto BM, MSi

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Proofreading
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Tudor Papuc **<ptudor2008@yahoo.com>** **Sat, Aug 7, 2021 at 6:57 PM**
Reply-To: Tudor Papuc <ptudor2008@yahoo.com>
To: nugroho sumarjiyanto
<nugroho.sbm@gmail.com>

Hello, I know it is a little late, but I am actually working right now on your paper, and hope to finish the English corrections and formatting (while writing the comments from reviewers) in 1-2 days.
So I am sending you the paper in 1-2 days (I am working only on your paper right now, until I finish with this step, so it shouldn't take too long).

Best Regards,
Tudor Păpuc
Editor, Bioflux

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Reviewer Comment #1
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Tudor Papuc **<ptudor2008@yahoo.com>** **Sun, Aug 8, 2021 at 4:25 PM**
Reply-To: Tudor Papuc <ptudor2008@yahoo.com>
To: nugroho sumarjiyanto
<nugroho.sbm@gmail.com>

Hello, I am back with the paper with comments. What you need to do is this:

1. Read all the paper carefully, because the English was corrected and the text was formatted.

2. Read carefully all the comments first (before starting the corrections) and try to correct as best as you can. Please work on this version of the manuscript. Please mark your changes (highlight with yellow, or use track changes; you can also leave the comments), so I can check them**. If you cannot correct, do not wish to doso, or have your own explanations, please write the reason as a reply to the comment or as a new comment.**

3. If you have anything to add/change to the text not based on comments, please do so, but mark the changes like in point 2.

4. Try to respect the formatting when making changes.

5. After you make the corrections, please check again, to make sure everything is in order.

6. Send me back the corrected version of the manuscript.

The references will be verified after revisions are made.
I will check it, give it a final form, and send you the final version for a last check before publication. Thank you,
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Fishermen behavior in the use of information and communication technologies (ICTs) in Central Java Province, Indonesia: Comparative study in Pati and Pemalang regencies

[1]Nugroho SBM, [1]Indah Susilowati, [2]Mudjahirin Thohir,[3]Made Ika Prastyadewi, [1]Ika Suciati

[1] Faculty of Economics and Business, Diponegoro University, UNDIP Tembalang Campus, Semarang, Indonesia; [2] Faculty of Humanities, Diponegoro University, UNDIP Tembalang Campus, Semarang, Indonesia; [3] Faculty of Economics and Business, Mahasaraswati University, Denpasar, Indonesia. Corresponding author: S. B. M. Nugroho, nugroho.sbm@gmail.com

Commented [u1]: please write the full name here

Abstract**. The fourth industrial revolution requires the readiness in the use of information and communication technologies (ICTs) for fisheries and farming in addition to the industrial sector. Moreover, climate change in the last decade leads to the development of technologies to create tools in facilitating the convenience to head seaward. The tools do not rely on natural cues of fishing locations at sea, because fishermen awareness in using technologies should help improve fisheries products. This research combined a quantitative and qualitative approach (mixed methods), as the research purposes were to compare fisheries awareness level in the use of ICTs in two potential fishing locations in the northern coastal area of Central Java, namely Pati and Pemalang regencies. The results showed that fishermen awareness was high in the use of ICTs based in the two fishing locations. The fishermen awareness in Pati regency was higher than in Pemalang regency based on age, while fishermen awareness in Pemalang regency was higher than in Pati regency based on the level of education. Uncertainty of income, the difficulty of internet coverage on the water, and the level of education become constraints in the use of ICTs in the fisheries sector. Accompaniment and modifications in the application features could help improve the use of ICTs in the fisheries sector.**

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Keywords**: small_scale, fisherman, climate_change, ICTs, Pati-Pemalang**

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Introduction**. Information and communication technologies (ICTs) in the field of fisheries vary with the use of GPS, sonars, wireless devices, computers, internet and cellphones. ICTs are seen as being able to offer a socio-economic improvement for fishermen, simplify the communication process and increase safety (Omar et al 2011). ICTs such as the Cloud, Internet of Things (IoT), location-based monitoring (remote sensing, geographic information and drones), and Big Data will play a key role in achieving innovative food security in the context of the digital economy (El Bilali & Allahyari 2018). The availability of information such as the distribution of fish catches, fishing gear used, and vessel size is required for proper management of plans in the management of capture fisheries businesses (Previero & Gasalla 2018). Information regarding fish catchment areas will be very important to overcome the problems of seizing fish catchment areas and overfishing areas (Simbolon et al 2011; Arifah 2018).**

Despite having abundant fishery resources, the involvement of the community, especially fishermen, will be needed in balancing the use and conservation of fishery resources (Suharno et al 2017). Therefore, information in the form of a decision system is what is needed to support fishing activities and ship operations. The rapid use of information and telecommunications technology can create cost efficiency in fisheries sectors (Arifah 2018). Provision of appropriate information and technology will be of great benefit to fishermen and entrepreneurs engaged in fishing. The price information of fish is needed related to the fish price trading system, while information related to weather forecasts and sea waves is needed by fishermen because it is related to safety while sailing (Muawanah et al 2018).

Climate change that occurs due to global warming is currently having an impact on the existence of traditional fishermen who rely on natural

cues to determine the location of their catch at sea. Climate change makes the situation of fishery resources vulnerable and also makes fishermen uncomfortable. Until now, many fishermen have not prepared for climate change (Hartoko et al 2010). A low level of education, difficulty in finding work until a relatively old age are reasons fishermen continue to surviving as fishers (Tantra et al 2020). Therefore, the use of ICTs in the form of applications that can be used by fishermen in fishing activities is needed. The use of information system applications for fishermen will be related to the person's awareness of ICTs. Therefore, this study aimed to: (1) analyze fishermen awareness in the use of ICTs in fisheries and 2) analyze the factors that support optimizing the use of ICTs in fisheries.

Material and Method

Study sites. **Rudiawan et al (2012) state that the use of information systems can change the way fishermen work. The use of a technology system in the form of Potential Fishing Zone (PFZ) - "Zona Potensi Penangkapan Ikan" (ZPPI) - maps must still be accompanied by training on how to read maps and navigation technology or GPS. Android-based information systems are very useful for fishermen, both for the fishing process and for marketing their catch. As pointed out by Chhachhar & Omar (2012), fishermen can get the latest information about the weather and can also save time by using cell phones. Mobile cellphones give fishermen the option to reduce risk, especially in emergencies when at sea.**

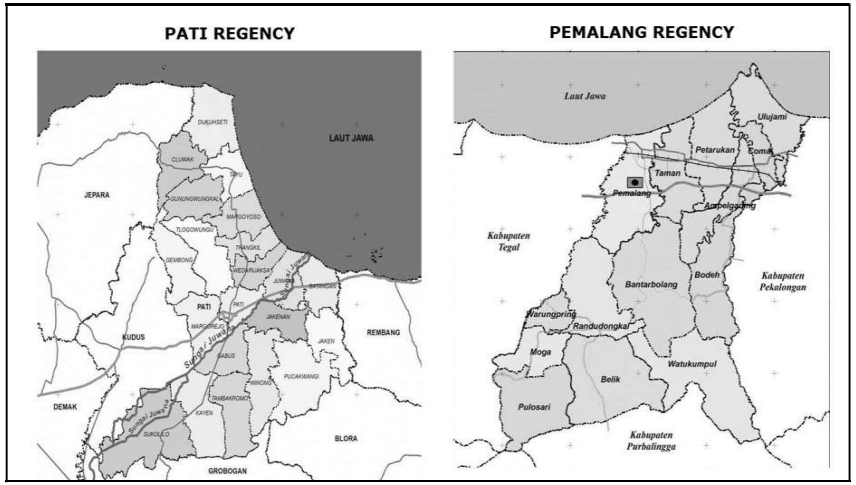

Figure 1. Study sites in Pati and Pemalang regencies, Central Java Province, Indonesia.

This research took place in the northern coastal area of Central Java. Banyutowo village, Dukuhseti district, Pati Regency and Asem Doyong village, Pemalang Regency were selected as research locations. Pati and Pemalang regencies were chosen because they are one of the pilot project areas for the application of the Fisheries Application from the Ministry of Fisheries and Marine Affairs based on the report of Marine and

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Commented [u5]: - this has nothing to do with Material and Method or study sites; however, the information is pertinent, so please try to move it somewhere it better fits (maybe in the discussion part)

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Fisheries Research and Human Resources Agency - Badan Riset dan Sumber Daya Manusia Kelautan dan Perikanan - (BRSDM). Pati and Pemalang regencies are also potential fishing areas in Central Java. Even though the fishermen in the fishing areas of these regencies have used several technologies related to fishing techniques, they have not yet made use of the existing information system application. Thus, this area was used as a pilot area with results that can be adopted by other fishermen from other fishing regions.

Method. **The method used in this study is a combination of quantitative analysis and qualitative analysis (mixed method) (Ardiansyah et al 2019). A quantitative approach was carried out through descriptive statistics and a qualitative approach through simple triangulation with the help of the Atlas.ti program. Respondents in this study consisted of 120 fishermen, of which 60 were from Pati and 60 from Pemalang. Samples were collected based on 2 times the requirements for a small sample of 30 respondents. Respondents were interviewed using a structured questionnaire for the quantitative analysis accompanied by in-depth interviews to obtain a clearer picture for qualitative analysis to support the research results. In-depth interviews were conducted with 12 key persons. Sampling of respondents was done by using the purposive sampling method. Key persons in this study were elements of A-B-G-C, which include academics, business people, the Fisheries and Marine Service of Pati and Pemalang regencies, the Department of Marine Affairs and Fisheries of Central Java Province, as well as the Head of Fishermen Groups.**

Results and Discussion

Fisheries characteristics. **Fisher in Banyutowo and Asemdoyong village were small-scale fishers based on the boat size with the average size of 10 gross ton (GT). This characteristic was related to the testing purposes of the Ministry of Fisheries and Marine Affairs stating that ICTs testing should be conducted only by small-scale fishermen, with 10 GT boats (Ministry of Fisheries and Marine Affairs go.id 2019). The fisheries characteristics from respondents can be seen in Table 1.**

Table 1

Fisheries characteristics

Variable		*Pati Regency*		*Pemalang Regency*	
		F	*(%)*	*F*	*(%)*
Boat size (GT)	<5 GT	49	81.7	3	5
	5-10 GT	11	18.3	43	71.7
	>10 GT	0	0	14	23.3
Operational trip duration (days)	< 1 days	34	56.7	19	31.7
	1-3 days	15	25	33	55
	4-6 days	11	18.3	8	13.3
Fish catching route (km)	0-2 km	9	15	6	10
	2-4 km	7	11.7	12	20
	5–12 km	27	45	33	55
	>12 km	17	10.2	9	15

Note: F -.

Table 1 shows the characteristics of fisheries in Banyutowo village, Pati Regency and Asemdoyo village, Pemalang Regency. Based on the boat size characteristic, the majority of fishermen in Pati Regency own boats with a size of less than 5 GT (81.7%), while the rest own boats with a size of 5-10 GT. Meanwhile, the majority of fishermen in Pemalang Regency own boats with a size of 5-10 GT (71.7%), while the rest own boats with a size of more than 10 GT (23.3%).

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The duration of the operational fishing trip is calculated based on the number of days the fishermen are at sea. The data shows that in both Pati and Pemalang regencies fishermen have an average operational trip duration of 1-3 days. Operational trip duration is supported by the size of the fishing boat. Meanwhile, when the characteristics of the fish catching route are compiled, fishermen from both locations have a range of less than 12 miles. A bigger the size of the boat with more storage space and supplies allow the ship to travel longer and have a better reach. On the other hand, a boat with a small size is able to accommodate only a limited number of supplies, so that it will have limited operational time and a closer fishing range. The description of the fishing area for Pati and Pemalang regencies is illustrated in Figure 2.

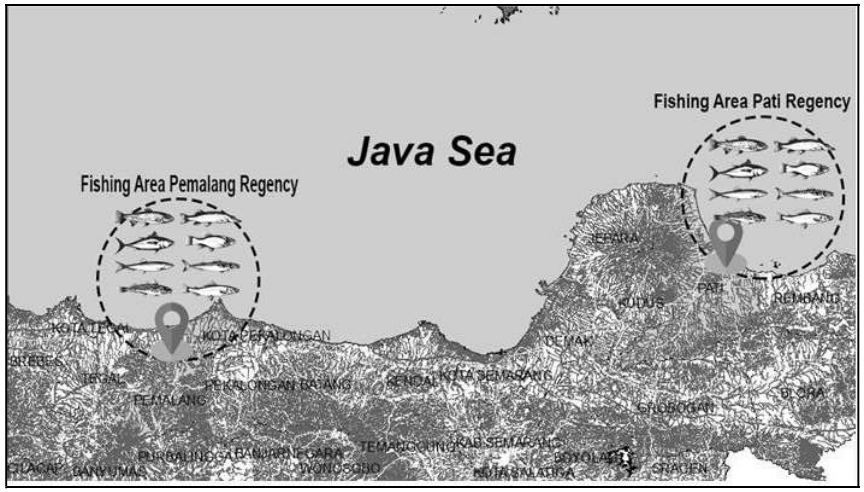

Figure 2. Fishing areas in Pati and Pemalang regencies.

Socio-economical characteristics of fishermen. **The socio-economical characteristics of fishermen in Banyutowo village, Pati Regency and Asemdoyo village, Pemalang Regency are described in the variables of age, successful year, and income. Table 2 shows the socio-economical characteristics of respondents.**

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Table 2

Socio-economical characteristics of fishermen

Variable		*Pati Regency*		*Pemalang Regency*	
		F	*(%)*	*F*	*(%)*
Age (years)	**<30**	**0**	**0**	**5**	**8.3**
	30–40	**21**	**35**	**28**	**46.7**

	41–50	23	38.3	20	33.3
	>50	16	26.7	7	11.7
Successful year*	0	1	1.7	5	8.3
	1-6	39	65.0	40	66.7
	7-9	10	16.7	12	20
	10-12	10	16.7	3	5
Income per fishing trip	<12 USD	17	28.3	20	33.3
	12–14 USD	20	33.3	31	51.7
	>14 USD	23	38.4	9	15

Note: F - . * - Successful year represented the level of education of fisher

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Commented [u13]: if this is true, please do the following: - throughout the paper, please replace "successful year" with "years of education", because the term "successful year" does not clearly show what you mean

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Table 2 shows a summary of the socio-economical characteristics of fishermen at the research locations. The age range of respondents in Pati and Pemalang regencies was mostly between the ages of 30 to 50 years. This shows that fishermen are at a productive age. The level of general knowledge of fishermen is low, indicated by the 1-6 of successful year, 65% in Pati and 66.7% in Pemalang. This shows that fishermen in the two study locations only completed basic education. Meanwhile, when viewed from the income of fishermen, the results of the survey show that the highest income of fishermen in Pati was 25 USD per trip, while the highest income of fishermen in Pemalang was 32 USD per trip.

Fishermen awareness in the use of information and communication technologies (ICTs). **ICTs in this study represents the use of information from BMKG, GPS, Fish Finder, television, and Windy application. The summary of fishermen perception toward ICTs of fisheries can be seen in Table 3.**

Table 3

Fishermen perception in fisheries information

Indicator of perception	*Pati Regency*		*Pemalang Regency*	
	F	*(%)*	*F*	*(%)*
Checking the condition of the sea weather and water information before going to the sea	33	82.5	54	90
Conformity of information with the real condition	33	82.5	40	66.7
The importance of fisheries information	38	95	52	86.7
The use of ICTs in fisheries	6	15	9	15
Constraints in the use of ICTs in fisheries	32	80	38	63.3
The pretension to access ICTs in fisheries	30	75	44	73.3
Mean	71.7%		65.8%	

Note: ICT - information and communication technology; F - .

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Table 3 shows the fishermen indicator of perception regarding fisheries information in Pati and Pemalang regencies. The data shows that fishermen have on average high perceptions of fisheries information. Based on the indicators, it can be seen that the fishermen perception of the importance of fisheries information in Pati Regency has the highest percentage, 95%. Meanwhile, for Pemalang, the highest indicator is information on the state of the waters and sea weather before going to sea, 90%. Fishermen awareness in the use of ICT systems has the lowest percentage in both Pati and Pemalang regencies. The information obtained also shows that fishermen in the two research locations have high obstacles or constraints in the use of ICTs systems, even though they have a high pretension to access the sea information from ICT systems.

Information related to the type of ICTs used by fishermen in both research locations is described in Figure 3.

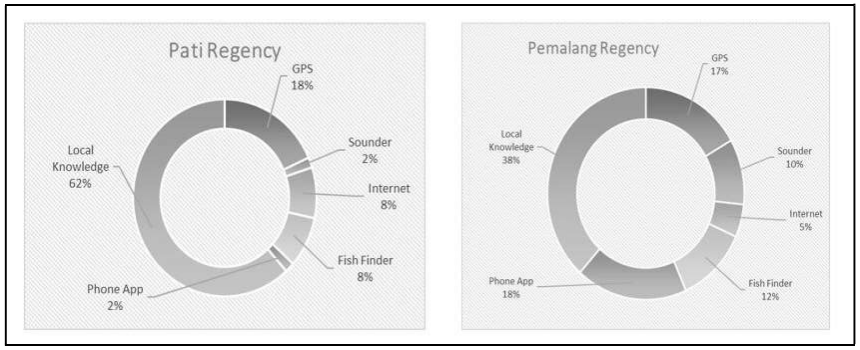

Figure 3. Information and communication technologies used by fishermen when sailing.

Figure 3 shows the types of ICT used by fishermen when fishing. From the total respondents in Pati, 62% use the determination of fishing locations and information on weather conditions in the traditional way, following natural cues. Meanwhile, respondents in Pemalang who still use natural cues or local knowledge represent 38%. This is due to the perception of fishermen, who state that natural cues can still describe weather conditions at sea. The use of traditional methods is still relevant to catching fish and other reasons are further explained using triangulation analysis, which is represented using the Atlas.Ti software. The traditional way to find information by reading natural cues was the most common practice among respondents in both Pati and Pemalang.

The analysis showed that 18% of respondents in Pati and 17% of respondents in Pemalang use GPS as a tool for fishing. 8% of respondents in Pati and 12% of respondents in Pemalang use fish finder. 2% of respondents in Pati and 10% of respondents in Pemalang use sounder. 8% of respondents in Pati regency and 5% of respondents in Pemalang regency have been looking for information on the internet based on data from BMKG. The ICT systems in the form of an android application is mostly used by respondents in Pemalang, 18%, while in Pati Regency it is only 2%. From this information, it means that respondents in Pemalang are having higher digital literacy in technology than respondents in Pati.

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Commented [u17]: what is a sounder?

Commented [u18]: only android? or do you refer to a software application in general, in any type of operating system? because you have iOS for Apple, windows/mac/linux for PC, etc.; if you believe it is a general term, please change "android" to "software"

Table 4

Crosstab of age and education to the level of awareness in the use of information and communication technologies

Variable		*Level of awareness*							
		Pati Regency				*Pemalang Regency*			
		L	M	H	Total	L	M	H	Total
Age	<30	0	0	0	0	0	2	3	5
	30-40	0	5	16	21	7	4	17	28
	41-50	4	5	14	23	6	3	11	20

	>50	6	5	5	16	5	2	0	7
	Total	10	15	35	60	18	11	31	60
Education	0	1	0	0	1	3	1	1	5
	1-6	8	14	17	39	6	10	23	39
	7-9	1	2	7	10	1	2	10	13
	10-12	0	3	7	10	0	0	3	3
	Total	10	19	31	60	10	13	37	60

Note: L - low; M - moderate; H - high. Processed by SPSS (2020)

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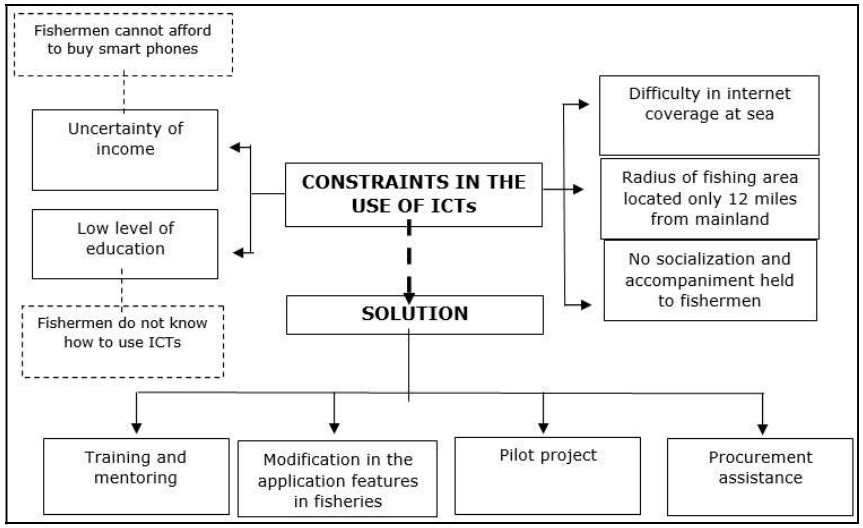
Table 4 shows the level of awareness of fishermen in the use of ICTs in Pati and Pemalang. 35 fishermen in Pati and 31 fishermen in Pemalang have a high level of awareness in using ICTs in terms of age. 31 fishermen in Pati and 37 fishermen in Pemalang have a high level of awareness in using ICTs based on the level of education. This shows that most fishermen care about the importance of ICTs for fishing activities. The majority of respondents who had a low level of education turned out to have a high level of awareness of using ICTs in both Pati and Pemalang regencies. Thus, the level of education of fishermen should not be an obstacle or constraint in implementing the use of service ICTs. It only takes training and mentoring to achieve the fourth industrial revolution in the fisheries sector.

Factors supporting the optimization of using ICTs. **Based on the results of in-depth interviews, the constraints in using ICTs at the research locations are the uncertainty of income, which causes the inability to buy smart phones or other supporting technology, inadequate socialization and mentoring, and low education. The last factor causes respondents to not know how to use the existing ICTs. In addition, the radius of the fishing area that is only 10 miles from the mainland is also a reason fishermen feel they do not need to use sophisticated technology. Internet coverage at sea is also low. Fishermen stated that they had difficulties accessing internet on high seas. According to stakeholders, the strategy to optimize the use of ICTs is to organize a pilot area through mentoring and modification of features in the applications, one of which is by adding features that can predict fish seasons. Thus, fishermen could use fishing gear according to the season. An overview of optimizing the use of ICTs is summarized in Figure 4.**

Commented [u20]: - you said one paragraph above that low education should not be an obstacle in using ICTs because the majority are aware, are using and care about ICTs;
-in this paragraph, you say that low education is a factor in not using ICTs; please rephrase somehow differently either before or in this paragraph, to clearly state what you mean, because as it is now it seems a contradiction



Processed by Atlas.TI (May 2020)

Figure 4. Optimization in the use of information and communication technologies (ICT) in fisheries.

According to Sabu et al (2017), the adoption of ICT system tools in the fisheries sector depends on several variables such as boat size, number of crew members, fishermen education, area specifications, duration of days per trip (operational trip duration), and the distance to the fishing grounds (fishing route). Figure 2 shows the results that fisher awareness about the use of ICTs applications for fisheries is quite high, as shown by the opinion of fisher about the importance of service information by 95%. However, about 85% of fishermen have problems in the use ICTs application. The constraints experienced by fishermen were put forward by Sugiono, the Head of the Fisher Group in Banyutowo village, who stated that fishermen want to use the fisherman application, because it helps them to know the weather and other conditions. However, he states that the main obstacle is that fishermen are not predisposed at learning to use the applications because it seems complicated. He says about himself that even he is sometimes confused when holding a cellphone and that another reason is the cost of a cellphone.

Before going to sea, fishermen look for information about water conditions. This is done to anticipate weather conditions when fishing in order to increase safety when sailing. Being a fisherman is a high-risk job highly dependent on natural conditions. The occurrence of climate variability can be in the form of shifts in rainfall, wave height, and wind speed, which can affect fishing operations (Azizi et al 2017). Information about fish catchment areas is very important to be applied to overcome the problems of seizing fish catchment areas and overfishing (Muhsoni et al 2009; Paul et al 2016). The response of small-scale fishermen to the existence of ICTs, as presented in this study, is still low, and the use of traditional methods dominates in helping fishing activities. Fishermen are aware that information about fishing locations, weather changes, and

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high sea waves is needed. The information technology referred to in this research is represented by BMKG, GPS, Fish Finder, television, and Windy application. Factors that affect fisheries production are season, weather, and technological advances such as the use of a GPS and Fish Finder to detect fish (Sulastri 2014). Other advances in information technology, such as fish prices in near-shore markets, will affect the stability of fishermen arrivals (Foss & Couclelis 2009).

The implementation of the fisheries information applications requires a re-assessment, especially for fishermen who are on the island of Java, where there are overfishing cases from time to time. Amperanto from Department of Fisheries and Marine Affairs in Central Java says that *small-scale fisher have only 12 miles* of fishing radius at sea from mainland. He notes that if a fisherman finds a fishing location at one point, some others will gather in groups to fish in the same point, which will cause overfishing, and this makes it more suitable and profitable for boats of more than 10 GT.

Another obstacle is that fishermen do not have a definite or certain income, so they cannot afford to buy supporting equipment such as GPS or mobile phones to help activities when they go to sea. Furthermore, the low level of education causes fishermen to not realize the importance of supporting ICTs in order to increase fishery production. The fishing route is also a constraint, as the small-scale fisherman can only fish in a radius of 12 miles from mainland. The fishing range also leads to difficult internet signal, as the internet coverage at sea is bad. In addition, there is a high risk of taking cellphones at the sea, because fishermen think that cellphone damage is difficult to avoid, while the cost of cellphones is high. Recommendations for increasing the application of service information are suggested by providing assistance, mentoring, and modification of service application features that are more suitable for small-scale fishermen. Things that need to be needed to overcome development problems in the fisheries value chain are technology adoption, government intervention, environmental awareness and fish farming organizations (Suharno et al 2017). This is in accordance with the statement of Rofik, from the Marine Fisheries Office of Pati regency, PPP Bajomulyo Branch, who stated that the small-scale fisherman does not use only one type of fishing gear; different seasons require different fishing gears, because the fish species will be different; the application should be completed with weather information and notifications, so that fishermen can predict what kind of fishing gears they would have to use in a certain season.

Feature adjustments in the fisheries application are needed because traditional fishermen are still confident in using traditional event modes or natural cues because fisher also quickly follow changes in nature overseas, although this estimate is not accurate in practice.

Conclusions. The use of ICTs is now something that can no longer be avoided. Based on the results of the analysis, it can be concluded that the level of awareness of fishermen in Pati Regency is higher than in Pemalang Regency in terms of age. The level of awareness of fishermen in Pemalang Regency is higher than in Pati Regency regarding the level of education. Fishermen in the two research locations have a high awareness of the importance and usefulness of ICTs in assisting fishing activities. Even so, information technology has not been widely used. Capital for technology purchases and fishermen reluctance to study the new technology are constraints that still need to be overcome in the use of ICTs system in the fisheries sector, especially in the northern coastal areas of Central Java, Indonesia.

Conflict of Interest. The authors declare that there is no conflict of interest.

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Fishermen behavior in the use of information and communication technologies (ICTs) in Central Java Province, Indonesia: Comparative study in Pati and Pemalang regencies

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Abstract. **The fourth industrial revolution requires the readiness in the use of information and communication technologies (ICTs) for fisheries and farming in addition to the industrial sector. Moreover, climate change in the last decade leads to the development of technologies to create tools in facilitating fishermen in the activity of fish catching. The tools do not rely on natural cues of fishing locations at sea, because fishermen awareness in using technologies should help improve fisheries products. This research combined a quantitative and qualitative approach (mixed methods), as the research purpose was to compare fisheries awareness level in the use of ICTs in two potential fishing locations in the northern**

coastal area of Central Java, namely Pati and Pemalang regencies. The results showed that fishermen awareness was high in the use of ICTs in the two fishing locations. The fishermen awareness in Pati regency was higher than in Pemalang regency based on age, while fishermen awareness in Pemalang regency was higher than in Pati regency based on the level of education. Uncertainty of income, the difficulty of internet coverage on the water, and the level of education become constraints in the use of ICTs in the fisheries sector. Accompaniment and modifications in the application features could help improve the use of ICTs in the fisheries sector.
Keywords: **climate change, fisher, ICTs, Pati, Pemalang, small scale**

Introduction. **Information and communication technologies (ICTs) in the field of fisheries vary with the use of GPS, sonars, wireless devices, computers, internet and cellphones. ICTs are seen as being able to offer a socio-economic improvement for fishermen, simplify the communication process, and increase safety (Omar et al., 2011). ICTs such as the Cloud, Internet of Things (IoT), location-based monitoring (remote sensing, geographic information and drones), and Big Data will play a key role in achieving innovative food security in the context of the digital economy (El Bilali & Allahyari, 2018). The availability of information such as the distribution of fish catches, fishing gear used, and vessel size is required for proper management of plans in the management of fish catching businesses (Previero & Gasalla, 2018). Information regarding fish catching areas will be very important to overcome the problems of seizing fish catching areas and overfishing areas (Simbolon et al., 2011; Arifah, 2018).**

Despite having abundant fishery resources, the involvement of the community, especially fishermen, will be needed in balancing the use and conservation of fishery resources (Suharno et al., 2017). Therefore, information in the form of a decision system is needed to support fishing activities and ship operations. The rapid use of information and telecommunications technology can create cost efficiency in fisheries sectors (Arifah, 2018). Provision of appropriate information and technology will be of great benefit to fishermen and entrepreneurs engaged in fishing. The price information of fish is needed related to the fish price trading system, while information related to weather forecasts and sea waves is needed by fishermen because it is related to safety while sailing (Muawanah et al., 2018).

Climate change that occurs due to global warming is currently having an impact on the existence of traditional fishermen who rely on natural cues to determine the location of their catch at sea. Climate change makes the situation of fishery resources vulnerable and also makes fishermen uncomfortable. Until now, many fishermen have not prepared for climate change (Hartoko et al., 2010). Low level of education and difficulty in finding work aside from being fishermen, despite the relatively old age, are reasons for fishermen to continue working as fishermen (Tantra et al., 2020). Therefore, the use of ICTs in the form of applications that can be used by fishermen in fishing activities is needed. The use of information system applications for fishermen will be related to the person's awareness of ICTs. Therefore, this study aimed to: (1) analyze fishermen awareness in the use of ICTs in fisheries and 2) analyze the factors that support optimizing the use of ICTs in fisheries.

Material and Method

Study sites. **This research took place in the northern coastal area of Central Java. Banyutowo village, Dukuhseti district, Pati Regency and Asem Doyong village, Pemalang Regency were selected as research locations. Pati and Pemalang regencies were chosen because they were one of the pilot project areas for the application of the Fisheries Application from the Ministry of Fisheries and Marine Affairs based on the report of Marine and Fisheries Research and Human Resources Agency - Badan Riset dan Sumber Daya Manusia Kelautan dan Perikanan - (BRSDM). Pati and Pemalang regencies were also potential fishing areas in Central Java. Even though the fishermen in the fishing areas of these regencies have used several technologies related to fishing techniques, they have not yet made use of the existing information system application. Thus, these areas were used as pilot area with results that can be adopted by other fishermen from other fishing regions. This research was conducted from November 2019 to July 2020. The study sites are shown in Figure 1 as follows.**

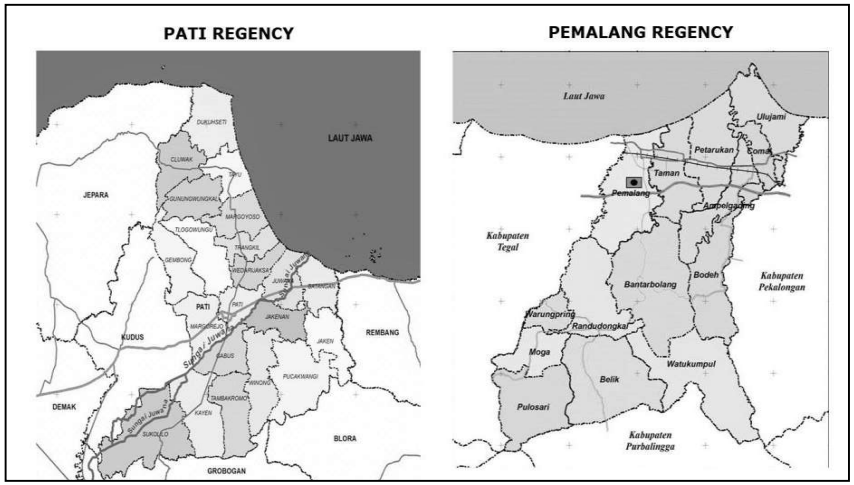


Figure 1. Study sites in Pati and Pemalang regencies, Central Java Province, Indonesia.

Method. **The method used in this study is a combination of quantitative analysis and qualitative analysis (mixed method) (Ardiansyah et al., 2019; Prastyadewi et al., 2020). A quantitative approach was carried out through descriptive statistics and a qualitative approach through simple triangulation with the help of the Atlas.ti program. Respondents in this study consisted of 120 fishermen, of which 60 were from Pati and 60 from Pemalang. Samples were collected based on 2 times the requirements for a small sample of 30 respondents (Perneger et al., 2015). It is often suggested that a sample size of 30 will produce an approximately normal sampling distribution for the sample mean from a non-normal parent distribution (Islam, 2018). Respondents were interviewed using a structured questionnaire for the quantitative analysis accompanied by in-depth interviews to obtain a clearer picture for qualitative analysis to support the research results. In-depth interviews were conducted with 12 key persons. Sampling of respondents was done by using the purposive sampling method. Key persons in this study were elements of A-B-G-C, which include academics, business people, the Fisheries and Marine Service of Pati and Pemalang regencies, the Department of Marine Affairs and Fisheries of Central Java Province, as well as the Head of Fishermen Groups.**

Results and Discussion

Fishermen characteristics. **Fishermen in Banyutowo and Asemdoyong village were small-scale fishermen based on the boat size with the average size of 10 gross ton (GT). This characteristic was related to the testing purposes of the Ministry of Fisheries and Marine Affairs which stated that ICTs testing should be conducted only by small-scale fishermen, with 10 GT boats (Ministry of Fisheries and Marine Affairs, 2019). The fishermen characteristics from respondents can be seen in Table 1.**

Table 1

Fishermen characteristics

Variable		*Pati Regency*		*Pemalang Regency*	
		F	*(%)*	*F*	*(%)*
Boat size (GT)	<5 GT	49	81.7	3	5
	5-10 GT	11	18.3	43	71.7
	>10 GT	0	0	14	23.3
Operational trip duration (days)	< 1 days	34	56.7	19	31.7
	1-3 days	15	25	33	55
	4-6 days	11	18.3	8	13.3
Fish catching route (km)	0-2 km	9	15	6	10
	2-4 km	7	11.7	12	20
	5–12 km	27	45	33	55
	>12 km	17	10.2	9	15

Note: F: frequency

Table 1 shows the characteristics of fishermen in Banyutowo village, Pati Regency and Asemdoyo village, Pemalang Regency. Based on the boat size characteristic, the majority of fishermen in Pati Regency owned boats with a size of less than 5 GT (81.7%), while the rest owned boats with a size of 5-10 GT. Meanwhile, the majority of fishermen in Pemalang Regency owned boats with a size of 5-10 GT (71.7%), while the rest owned boats with a size of more than 10 GT (23.3%).

The duration of the operational fishing trip was calculated based on the number of days the fishermen were at sea. The data showed that, in both Pati and Pemalang regencies, fishermen had an average operational trip duration of 1-3 days. Operational trip duration was supported by the size of the fishing boat. Meanwhile, when the characteristics of the fish catching route were compiled, fishermen from both locations had a range of less than 12 miles. The bigger the size of the boat with more storage space and supplies allowed the ship to travel longer and have a better reach. On the other hand, a boat with a small size was able to accommodate only a limited number of supplies, so that it would have limited operational time and a closer fish catching range. The description of the fish catching areas for Pati and Pemalang regencies is illustrated in Figure 2.

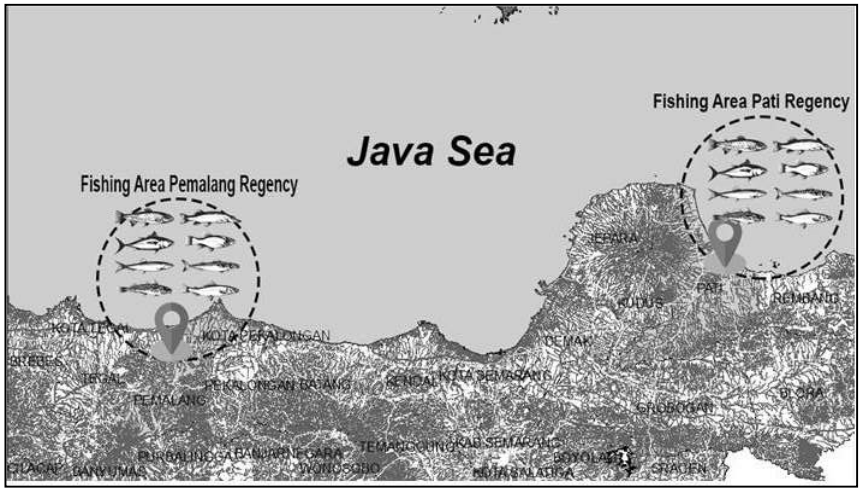


Figure 2. Fish catching areas in Pati and Pemalang regencies.

Socio-economical characteristics of fishermen. **The socio-economical characteristics of fishermen in Banyutowo village, Pati Regency and Asemdoyo village, Pemalang Regency were described in the variables of age, level of education, and income. Table 2 shows the socio-economical characteristics of respondents.**

Table 2

Socio-economical characteristics of fishermen

Variable		*Pati Regency*		*Pemalang Regency*	
		F	*(%)*	*F*	*(%)*
Age (years)	**<30**	**0**	**0**	**5**	**8.3**
	30–40	**21**	**35**	**28**	**46.7**
	41–50	**23**	**38.3**	**20**	**33.3**
	>50	**16**	**26.7**	**7**	**11.7**
Level of education	**0**	**1**	**1.7**	**5**	**8.3**
	1-6	**39**	**65.0**	**40**	**66.7**
	7-9	**10**	**16.7**	**12**	**20**
	10-12	**10**	**16.7**	**3**	**5**
Income per fishing trip	**<12 USD**	**17**	**28.3**	**20**	**33.3**

12–14 USD	20	33.3	31	51.7
>14 USD	23	38.4	9	15

Note: F = frequency

Table 2 shows a summary of the socio-economical characteristics of fishermen at the research locations. The age range of respondents in Pati and Pemalang regencies was mostly between the ages of 30 to 50 years. This showed that fishermen were at a productive age. The level of general knowledge of fishermen was low, indicated by the 1-6 of level of education, 65% in Pati and 66.7% in Pemalang. This showed that fishermen in the two study locations only completed basic education. Meanwhile, based on the income of fishermen, the results of the survey showed that the highest income of fishermen in Pati was 25 USD per trip, while the highest income of fishermen in Pemalang was 32 USD per trip.

Fishermen awareness in the use of information and communication technologies (ICTs). ICTs in this study represents the use of information from BMKG, GPS, Fish Finder, television, and Windy application. The summary of fishermen perception toward ICTs of fisheries can be seen in Table 3.

Table 3

Fishermen perception in fisheries information

Indicator of perception	*Pati Regency*		*Pemalang Regency*	
	F	*(%)*	*F*	*(%)*
Checking the condition of the sea weather and water information before going to the sea	33	82.5	54	90
Conformity of information with the real condition	33	82.5	40	66.7
The importance of fisheries information	38	95	52	86.7
The use of ICTs in fisheries	6	15	9	15
Constraints in the use of ICTs in fisheries	32	80	38	63.3
The pretension to access ICTs in fisheries	30	75	44	73.3
Mean	71.7%		65.8%	

Note: ICT - information and communication technology; F - frequency.

Table 3 shows the fishermen indicator of perception regarding fisheries information in Pati and Pemalang regencies. The data showed that fishermen had on average high perceptions of fisheries information. Based on the indicators, it can be seen that the fishermen perception of the importance of fisheries information in Pati Regency had the highest percentage, 95%. Meanwhile, for Pemalang, the highest indicator was information on the state of the waters and sea weather before going to sea, 90%. Fishermen awareness in the use of ICT systems had the lowest percentage in both Pati and Pemalang regencies. The information obtained also showed that fishermen in the two research locations had high obstacles or constraints in the use of ICTs systems, even though they had a high pretension to access the sea information from ICT systems.

Information related to the type of ICTs used by fishermen in both research locations is described in Figure 3.

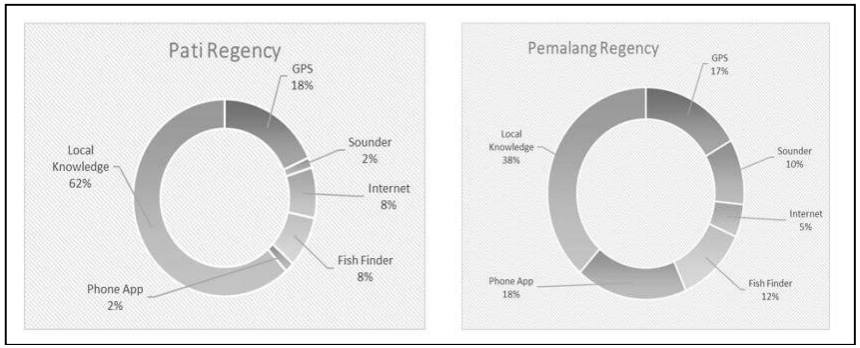


Figure 3. Information and communication technologies used by fishermen when sailing.

Figure 3 shows the types of ICT used by fishermen when fishing. From the total respondents in Pati, 62% used the determination of fishing locations and information on weather conditions in the traditional way, following natural cues. Meanwhile, respondents in Pemalang who still used natural cues or local knowledge were 38% of the total respondents. This was due to the perception of fishermen who stated that natural cues could still describe weather conditions at sea. The use of traditional methods was still relevant to catch fish and for other reasons which were further explained through triangulation analysis using the Atlas.Ti software. The traditional way to find information by reading natural cues was the most common practice among respondents in both Pati and Pemalang.

The analysis showed that 18% of respondents in Pati and 17% of respondents in Pemalang used GPS as a tool for fishing. 8% of respondents in Pati and 12% of respondents in Pemalang used fish finder. 2% of respondents in Pati and 10% of respondents in Pemalang used sounder/fish finder. 8% of respondents in Pati regency and 5% of respondents in Pemalang regency had been looking for information on the internet based on data from BMKG. The ICT systems in the form of a software application were mostly used by respondents in Pemalang that was 18% of the respondents, while in Pati Regency it was only 2%. From this information, it means that respondents in Pemalang had higher digital literacy in technology than respondents in Pati.

Table 4
Crosstab of age and education to the level of awareness in the use of information and communication technologies

Variable		*Level of awareness*							
		Pati Regency				*Pemalang Regency*			
		L	M	H	Total	L	M	H	Total
Age	<30	0	0	0	0	0	2	3	5
	30-40	0	5	16	21	7	4	17	28
	41-50	4	5	14	23	6	3	11	20
	>50	6	5	5	16	5	2	0	7

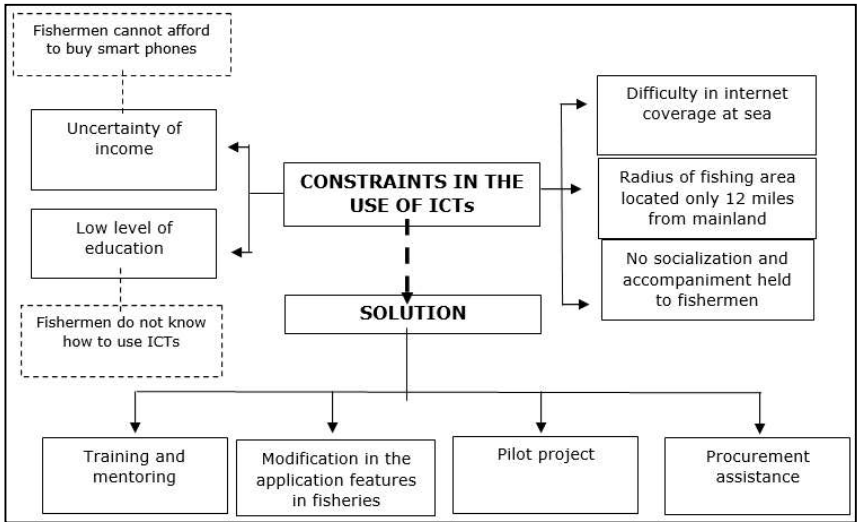
	Total	10	15	35	60	18	11	31	60
Education	0	1	0	0	1	3	1	1	5
	1-6	8	14	17	39	6	10	23	39
	7-9	1	2	7	10	1	2	10	13
	10-12	0	3	7	10	0	0	3	3
	Total	10	19	31	60	10	13	37	60

Note: L - low; M - moderate; H - high.
Source: Primary data processed, 2020

Table 4 shows the level of awareness of fishermen in the use of ICTs in Pati and Pemalang. 35 fishermen in Pati and 31 fishermen in Pemalang had high level of awareness in using ICTs in terms of age. 31 fishermen in Pati and 37 fishermen in Pemalang had high level of awareness in using ICTs based on the level of education. This showed that most fishermen cared about the importance of ICTs for fishing activities. The majority of respondents who had a low level of education turned out to have a high level of awareness of using ICTs in both Pati and Pemalang regencies. Thus, the level of education of fishermen should not be an obstacle or constraint in implementing the use of service ICTs. It only takes training and mentoring to achieve the fourth industrial revolution in the fisheries sector.

Rudiawan et al. (2012) state that the use of information systems can change the way fishermen work. The use of a technology system in the form of Potential Fishing Zone (PFZ) - "Zona Potensi Penangkapan Ikan" (ZPPI) - maps must still be accompanied by training on how to read maps and navigation technology or GPS. Android-based information systems are very useful for fishermen, both for the fishing process and for marketing their catch. As pointed out by Chhachhar & Omar (2012), fishermen can get the latest information about the weather and can also save time by using cell phones. Mobile cellphones give fishermen the option to reduce risk, especially in emergency situations when they are at sea.

Factors supporting the optimization of using ICTs. Based on the results of in-depth interviews, the constraints in using ICTs at the research locations were the uncertainty of income which caused the inability to buy smart phones or other supporting technology, inadequate socialization and mentoring, and low education. Next, despite the fact that level of education did not affect the fishermen awareness in making use of technology, the fishermen's low level of education became a particular constraint in gaining immediate comprehension on the use of the available information and communication technologies.
In addition, the radius of the fishing area that was only 10 miles from the mainland was also a reason fishermen felt that they did not need to use sophisticated technology. Internet coverage at sea was also low. Fishermen stated that they had difficulties in accessing internet on high seas. According to stakeholders, the strategy to optimize the use of ICTs was to organize a pilot area through mentoring and modification of features in the applications, one of which was by adding features that can predict fish seasons. Thus, fishermen could use fishing gear according to the season. An overview of optimizing the use of ICTs is summarized in Figure 4.



Source: Promary data processed, 2020

Figure 4. Optimization in the use of information and communication technologies (ICT) in fisheries.

According to Sabu et al. (2017), the adoption of ICT system tools in the fisheries sector depends on several variables such as boat size, number of crew members, fishermen education, area specifications, duration of days per trip (operational trip duration), and the distance to the fishing grounds (fishing route). Figure 4 showed that fishermen awareness about the use of ICTs applications for fisheries was quite high which was shown by the opinion of fishermen about the importance of service information 95% of the total respondents agreed on the importance of service information. However, about 85% of fishermen had problems in the use ICTs application. The constraints experienced by fishermen were put forward by the Head of the Fishermen in Banyutowo village, who stated that fishermen wanted to use the fishermen application because it helped them to know the weather and other conditions. However, he stated that the main obstacle was that fishermen were not predisposed at learning to use the applications because it seemed complicated. He pronounced that even he himself is sometimes confused when using a cellphone and another reason is the high cost of accessing through a cellphone.

Before going to sea, fishermen looked for information about water conditions. This was done to anticipate weather conditions when fishing in order to increase safety when sailing. Being a fisherman is a high-risk job which is highly dependent on natural conditions. The occurrence of climate variability can be in the form of shifts in rainfall, wave height, and wind speed, which can affect fishing operations (Azizi et al., 2017). Information about fish catching areas is very important to be applied to overcome the problems of seizing fish catching areas and areas which was categorized as overfishing areas (Muhsoni et al., 2009; Paul et al., 2016). The response of small-scale fishermen to the existence of ICTs,

as presented in this study, was still low, and the use of traditional methods dominated in helping fishing activities. Fishermen were aware that information about fishing locations, weather changes, and high sea waves were needed. The information technology referred to in this research was represented by BMKG, GPS, Fish Finder, television, and Windy application. Factors that affect fisheries production are season, weather, and technological advances such as the use of a GPS and Fish Finder to detect fish (Sulastri, 2014). Other advances in information technology, such as fish prices in near-shore markets, will affect the stability of fishermen arrivals (Foss & Couclelis 2009).

The implementation of the fisheries information applications required a re-assessment, especially for fishermen who were on the island of Java, where there were overfishing cases from time to time. Employee of the Department of Fisheries and Marine Affairs in Central Java said that *small-scale fisher have only 12 miles* of fishing radius at sea from mainland. He noted that if a fisherman found a fishing location at one point, some others would gather in groups to fish in the same point, which would cause overfishing, and this made it more suitable and profitable for boats of more than 10 GT.

Another obstacle was that fishermen did not have a definite or certain income, so they could not afford to buy supporting equipment such as GPS or mobile phones to help their fishing activities when they went to sea. Furthermore, the low level of education caused fishermen to not realize the importance of supporting ICTs in order to increase fishery production. The fishing route was also a constraint, as the small-scale fisherman could only fish in a radius of 12 miles from mainland. The fishing range also led to difficult internet signal, as the internet coverage at sea was bad. In addition, there was a high risk of taking cellphones at the sea, because fishermen thought that cellphone damage was difficult to avoid, while the cost of cellphones was high. Recommendations for increasing the application of service information were suggested by providing assistance, mentoring, and modification of service application features that are more suitable for small-scale fishermen. Things that need to be accommodated to overcome development problems in the fisheries value chain are technology adoption, government intervention, environmental awareness, and fish farming organizations (Suharno et al., 2017). This is in accordance with the statement of employment the Marine Fisheries Office of Pati regency, PPP Bajomulyo Branch, who stated that the small-scale fisherman did not use only one type of fishing gear; different seasons required different fishing gears, because the fish species would be different; the application should be completed with weather information and notifications, so that fishermen could predict what kind of fishing gears they would have to use in a certain season.

Feature adjustments in the fisheries application were needed because traditional fishermen were still confident in using traditional event modes or natural cues because fishermen also quickly followed changes in nature overseas, although this estimation was not accurate in practice.

Conclusions. The use of ICTs is now something that can no longer be avoided. Based on the results of the analysis, it can be concluded that the level of awareness of fishermen in Pati Regency was higher than in Pemalang Regency in terms of age. The level of awareness of fishermen in Pemalang Regency was higher than in Pati Regency regarding the level of education. Fishermen in the two research locations had high awareness of the importance and usefulness of ICTs in assisting fishing activities. Even so, information technology had not been widely used. Capital for technology purchases and fishermen reluctance to study the new technology were the constraints that still needed to be overcome in the use of ICTs system in the fisheries sector, especially in the northern coastal areas of Central Java, Indonesia.

Conflict of Interest. The authors declare that there is no conflict of interest.

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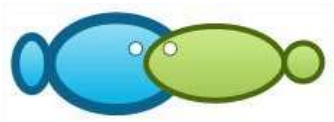

Fishermen behavior in the use of information and communication technologies (ICTs) in Central Java Province, Indonesia: Comparative study in Pati and Pemalang regencies

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Abstract. **The fourth industrial revolution requires the readiness in the use of information and communication technologies (ICTs) for fisheries and farming in addition to the industrial sector. Moreover, climate change in the last decade leads to the development of new technologies that create tools in facilitating fishing activities. The tools do not rely on natural cues of fishing locations at sea, because fishermen awareness in using technologies should help improve fisheries products. This research combined a quantitative and qualitative approach (mixed methods), as the research purpose was to compare fisheries awareness level in the use of ICTs in two potential fishing locations in the northern coastal area of Central Java, namely Pati and Pemalang regencies. The results showed that fishermen awareness was high in the use of ICTs in the two fishing locations. The fishermen awareness in Pati regency was higher than in Pemalang regency based on age, while fishermen awareness in Pemalang regency was higher than in Pati regency based on the level of education. Uncertainty of income, the difficulty of internet coverage on the water, and the level of education become constraints in the use of ICTs in the fisheries sector. Accompaniment and modifications in the application features could help improve the use of ICTs in the fisheries sector.**
Keywords: **climate change, fisher, ICTs, Pati, Pemalang, small scale.**

Introduction. **Information and communication technologies (ICTs) in the field of fisheries vary with the use of GPS, sonars, wireless devices, computers, internet and cellphones. ICTs are seen as being able to offer a socio-economic improvement for fishermen, simplify the communication process, and increase safety (Omar et al 2011). ICTs such as the Cloud, Internet of Things (IoT), location-based monitoring (remote sensing, geographic information and drones), and Big Data will play a key role in achieving innovative food security in the context of the digital economy (El Bilali & Allahyari 2018). The availability of information such as the distribution of fish catches, fishing gear used, and vessel size is required for proper management of plans in the management of fish catching businesses (Previero & Gasalla 2018). Information regarding fish catching areas will be very important to overcome the problems of seizing fish catching areas and overfishing areas (Simbolon et al 2011; Arifah 2018).**

Despite having abundant fishery resources, the involvement of the community, especially fishermen, will be needed in balancing the use and conservation of fishery resources (Suharno et al 2017a). Therefore, information in the form of a decision system is needed to support fishing activities and ship operations. The rapid use of information and telecommunications technology can create cost efficiency in fisheries sectors (Arifah 2018). Provision of appropriate information and technology will be of great benefit to fishermen and entrepreneurs engaged in fishing. The price information of fish is needed related to the fish price trading system, while information related to weather forecasts and sea waves is needed by fishermen because it is related to safety while sailing (Muawanah et al 2018).

Climate change that occurs due to global warming is currently having an impact on the existence of traditional fishermen who rely on natural cues to determine the location of their catch at sea. Climate change makes the situation of fishery resources vulnerable and also makes fishermen uncomfortable. Until now, many fishermen have not prepared for climate change (Hartoko et al 2010). Low level of education and difficulty in finding work aside from being fishermen, despite the relatively old age, are reasons for fishermen to continue working as fishermen (Tantra et al 2020). Therefore, the use of ICTs in the form of applications that can be used by fishermen in fishing activities is needed. The use of information system applications for fishermen will be related to the person's awareness of ICTs. Therefore, this study aimed to: (1) analyze fishermen awareness in the use of ICTs in fisheries and 2) analyze the factors that support optimizing the use of ICTs in fisheries.

Material and Method

Study sites. **This research took place in the northern coastal area of Central Java. Banyutowo village, Dukuhseti district, Pati Regency and Asem Doyong village, Pemalang Regency were selected as research locations. Pati and Pemalang regencies were chosen because they were one of the pilot project areas for the application of the Fisheries Application from the Ministry of Fisheries and Marine Affairs based on the report of Marine and Fisheries Research and Human Resources Agency - Badan Riset dan Sumber Daya Manusia Kelautan dan Perikanan - (BRSDM). Pati and Pemalang regencies were also potential fishing areas in Central Java. Even though the fishermen in the fishing areas of these regencies have used several technologies related to fishing techniques, they have not yet made use of the existing information system application. Thus,**

these areas were used as a pilot area with results that can be adopted by other fishermen from other fishing regions. This research was conducted from November 2019 to July 2020. The study sites are presented in Figure 1.

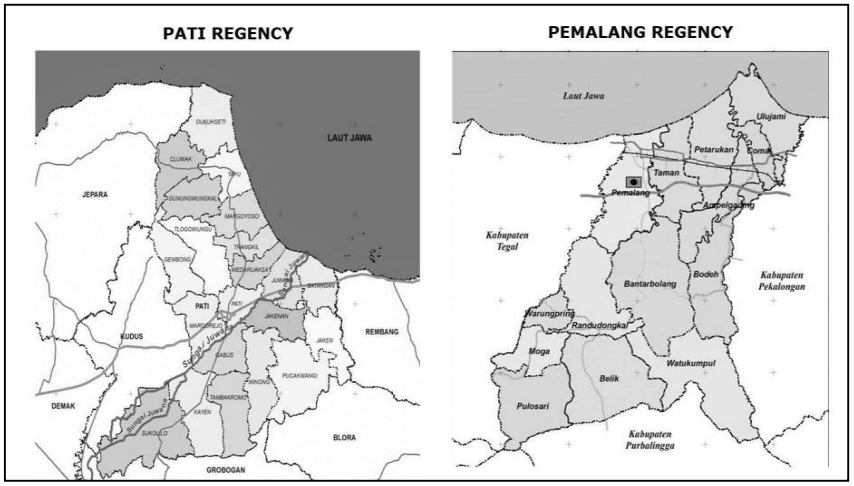

Figure 1. Study sites in Pati and Pemalang regencies, Central Java Province, Indonesia.

Method. **The method used in this study is a combination of quantitative analysis and qualitative analysis (mixed method) (Ardiansyah et al 2019; Prastyadewi et al 2020). A quantitative approach was carried out through descriptive statistics and a qualitative approach through simple triangulation with the help of the Atlas.ti program. Respondents in this study consisted of 120 fishermen, of which 60 were from Pati and 60 from Pemalang. The number of samples was double the requirements for the minimum of 30 respondents (Perneger et al 2015). It is often suggested that a sample size of 30 will produce an approximately normal sampling distribution for the sample mean from a non-normal parent distribution (Islam 2018). Respondents were interviewed using a structured questionnaire for the quantitative analysis accompanied by in-depth interviews to obtain a clearer picture for qualitative analysis to support the research results. In-depth interviews were conducted with 12 key persons. Sampling of respondents was done by using the purposive sampling method. Key persons in this study were elements of A-B-G-C, which include academics, business people, the Fisheries and Marine Service of Pati and Pemalang regencies, the Department of Marine Affairs and Fisheries of Central Java Province, as well as the Head of Fishermen Groups.**

Results and Discussion

Fishermen characteristics. **Fishermen in Banyutowo and Asemdoyong village were small-scale fishermen, with a boat size with the average size of 10 gross ton (GT). This characteristic was related to the testing purposes of the Ministry of Fisheries and Marine Affairs which stated that**

ICTs testing should be conducted only by small-scale fishermen, with 10 GT boats (Ministry of Fisheries and Marine Affairs, 2019). The fishermen characteristics from respondents can be seen in Table 1.

Table 1

Fishermen characteristics

Variable		*Pati Regency*		*Pemalang Regency*	
		F	*(%)*	*F*	*(%)*
Boat size (GT)	<5 GT	49	81.7	3	5
	5-10 GT	11	18.3	43	71.7
	>10 GT	0	0	14	23.3
Operational trip duration (days)	< 1 days	34	56.7	19	31.7
	1-3 days	15	25	33	55
	4-6 days	11	18.3	8	13.3
Fish catching route (km)	0-2 km	9	15	6	10
	2-4 km	7	11.7	12	20
	5–12 km	27	45	33	55
	>12 km	17	10.2	9	15

Note: F - frequency.

Table 1 shows the characteristics of fishermen in Banyutowo village, Pati Regency and Asemdoyo village, Pemalang Regency. Based on the boat size characteristic, the majority of fishermen in Pati Regency owned boats with a size of less than 5 GT (81.7%), while the rest owned boats with a size of 5-10 GT. Meanwhile, the majority of fishermen in Pemalang Regency owned boats with a size of 5-10 GT (71.7%), while the rest owned boats with a size of more than 10 GT (23.3%).

The duration of the operational fishing trip was calculated based on the number of days the fishermen were at sea. The data showed that, in both Pati and Pemalang regencies, fishermen had an average operational trip duration of 1-3 days. Operational trip duration was supported by the size of the fishing boat. Meanwhile, when the characteristics of the fish catching route were compiled, fishermen from both locations had a range of less than 12 miles. The bigger the size of the boat with more storage space and supplies allowed the ship to travel longer and have a better reach. On the other hand, a boat with a small size was able to accommodate only a limited number of supplies, so that it would have limited operational time and a closer fish catching range. The description of the fish catching areas for Pati and Pemalang regencies is illustrated in Figure 2.

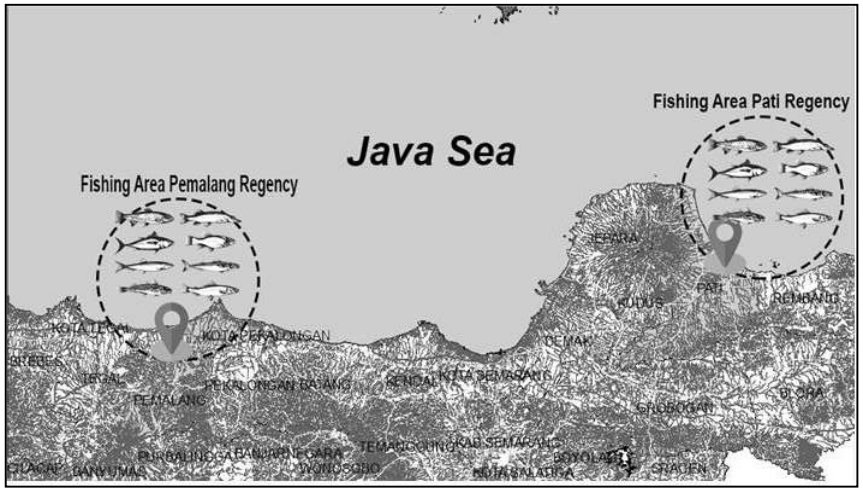

Figure 2. Fish catching areas in Pati and Pemalang regencies.

Socio-economical characteristics of fishermen. **The socio-economical characteristics of fishermen in Banyutowo village, Pati Regency and Asemdoyo village, Pemalang Regency were described in the variables of age, level of education, and income. Table 2 shows the socio-economical characteristics of respondents.**

Table 2

Socio-economical characteristics of fishermen

Variable		*Pati Regency*		*Pemalang Regency*	
		F	*(%)*	*F*	*(%)*
Age (years)	**<30**	**0**	**0**	**5**	**8.3**
	30–40	**21**	**35**	**28**	**46.7**
	41–50	**23**	**38.3**	**20**	**33.3**
	>50	**16**	**26.7**	**7**	**11.7**
Level of education	**0**	**1**	**1.7**	**5**	**8.3**
	1-6	**39**	**65.0**	**40**	**66.7**
	7-9	**10**	**16.7**	**12**	**20**
	10-12	**10**	**16.7**	**3**	**5**
Income per fishing trip	**<12 USD**	**17**	**28.3**	**20**	**33.3**

12–14 USD	20	33.3	31	51.7
>14 USD	23	38.4	9	15

Note: F - frequency.

Table 2 shows a summary of the socio-economical characteristics of fishermen at the research locations. The age range of respondents in Pati and Pemalang regencies was mostly between the ages of 30 to 50 years. This showed that fishermen were at a productive age. The level of general knowledge of fishermen was low, indicated by the 1-6 classes level of education, 65% in Pati and 66.7% in Pemalang. This showed that fishermen in the two study locations only completed basic education. Meanwhile, based on the income of fishermen, the results of the survey showed that the highest income of fishermen in Pati was 25 USD per trip, while the highest income of fishermen in Pemalang was 32 USD per trip.

Fishermen awareness in the use of information and communication technologies (ICTs). ICTs in this study represents the use of information from BMKG, GPS, Fish Finder, television, and Windy application. The summary of fishermen perception toward ICTs of fisheries can be seen in Table 3.

Table 3

Fishermen perception in fisheries information

Indicator of perception	*Pati Regency*		*Pemalang Regency*	
	F	*(%)*	*F*	*(%)*
Checking the condition of the sea weather and water information before going to the sea	33	82.5	54	90
Conformity of information with the real condition	33	82.5	40	66.7
The importance of fisheries information	38	95	52	86.7
The use of ICTs in fisheries	6	15	9	15
Constraints in the use of ICTs in fisheries	32	80	38	63.3
The pretension to access ICTs in fisheries	30	75	44	73.3
Mean	71.7%		65.8%	

Note: ICT - information and communication technology; F - frequency.

Table 3 shows the fishermen indicator of perception regarding fisheries information in Pati and Pemalang regencies. The data showed that fishermen had on average high perceptions of fisheries information. Based on the indicators, it can be seen that the fishermen perception of the importance of fisheries information in Pati Regency had the highest percentage, 95%. Meanwhile, for Pemalang, the highest indicator was information on the state of the waters and sea weather before going to sea, 90%. Fishermen awareness in the use of ICT systems had the lowest percentage in both Pati and Pemalang regencies. The information obtained also showed that fishermen in the two research locations had high obstacles or constraints in the use of ICTs systems, even though they had a high pretension to access the sea information from ICT systems.

Information related to the type of ICTs used by fishermen in both research locations is described in Figure 3.

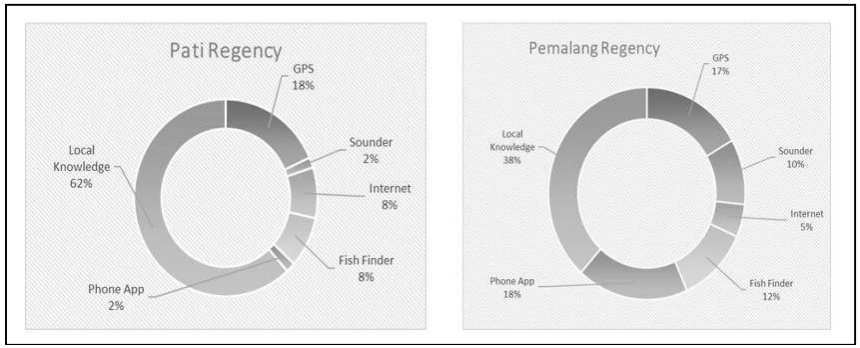

Figure 3. Information and communication technologies used by fishermen when sailing.

Figure 3 shows the types of ICT used by fishermen when fishing. From the total respondents in Pati, 62% used the determination of fishing locations and information on weather conditions in the traditional way, following natural cues. Meanwhile, respondents in Pemalang who still used natural cues or local knowledge were 38% of the total respondents. This was due to the perception of fishermen who stated that natural cues could still describe weather conditions at sea. The use of traditional methods was still relevant to catch fish and for other reasons which were further explained through triangulation analysis using the Atlas.ti software. The traditional way to find information by reading natural cues was the most common practice among respondents in both Pati and Pemalang.

The analysis showed that 18% of respondents in Pati and 17% of respondents in Pemalang used GPS as a tool for fishing. 8% of respondents in Pati and 12% of respondents in Pemalang used fish finder. 2% of respondents in Pati and 10% of respondents in Pemalang used sounders/fish finders. 8% of respondents in Pati regency and 5% of respondents in Pemalang regency had been looking for information on the internet based on data from BMKG. The ICT systems in the form of a software application were mostly used by respondents in Pemalang that was 18% of the respondents, while in Pati Regency it was only 2%. From this information, it means that respondents in Pemalang had higher digital literacy in technology than respondents in Pati.

Table 4

Crosstab of age and education to the level of awareness in the use of information and communication technologies

Variable		*Level of awareness*							
		Pati Regency				*Pemalang Regency*			
		L	M	H	Total	L	M	H	Total
Age	<30	0	0	0	0	0	2	3	5
	30-40	0	5	16	21	7	4	17	28
	41-50	4	5	14	23	6	3	11	20
	>50	6	5	5	16	5	2	0	7

	Total	**10**	**15**	**35**	**60**	**18**	**11**	**31**	**60**
Education	**0**	**1**	**0**	**0**	**1**	**3**	**1**	**1**	**5**
	1-6	**8**	**14**	**17**	**39**	**6**	**10**	**23**	**39**
	7-9	**1**	**2**	**7**	**10**	**1**	**2**	**10**	**13**
	10-12	**0**	**3**	**7**	**10**	**0**	**0**	**3**	**3**
	Total	**10**	**19**	**31**	**60**	**10**	**13**	**37**	**60**

Note: L - low; M - moderate; H - high.

Source: Primary data processed, 2020

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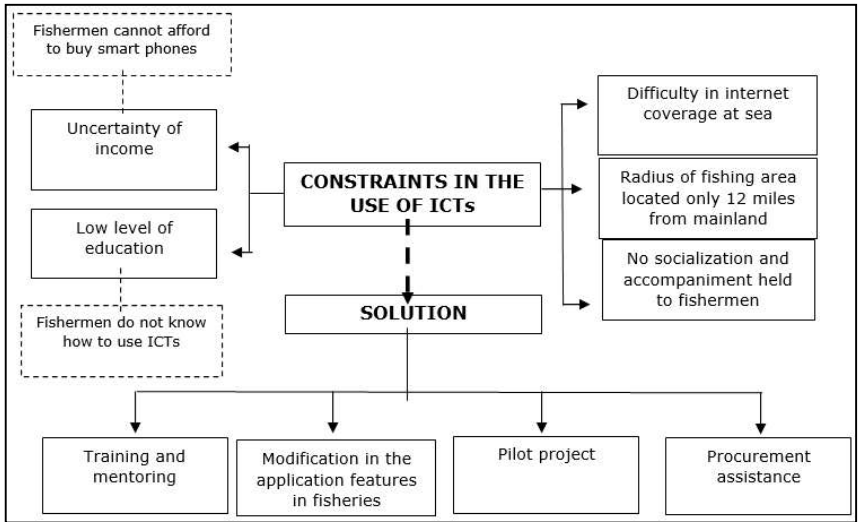
Table 4 shows the level of awareness of fishermen in the use of ICTs in Pati and Pemalang. 35 fishermen in Pati and 31 fishermen in Pemalang had high level of awareness in using ICTs in terms of age. 31 fishermen in Pati and 37 fishermen in Pemalang had high level of awareness in using ICTs based on the level of education. This showed that most fishermen cared about the importance of ICTs for fishing activities. The majority of respondents who had a low level of education turned out to have a high level of awareness of using ICTs in both Pati and Pemalang regencies. Thus, the level of education of fishermen should not be an obstacle or constraint in implementing the use of service ICTs. It only takes training and mentoring to achieve the fourth industrial revolution in the fisheries sector.

Rudiawan et al (2012) state that the use of information systems can change the way fishermen work. The use of a technology system in the form of Potential Fishing Zone (PFZ) - "Zona Potensi Penangkapan Ikan" (ZPPI) - maps must still be accompanied by training on how to read maps and navigation technology or GPS. Android-based information systems are very useful for fishermen, both for the fishing process and for marketing their catch. As pointed out by Chhachhar & Omar (2012), fishermen can get the latest information about the weather and can also save time by using cell phones. Mobile cellphones give fishermen the option to reduce risk, especially in emergency situations when they are at sea.

Factors supporting the optimization of using ICTs. **Based on the results of in-depth interviews, the constraints in using ICTs at the research locations were the uncertainty of income which caused the inability to buy smart phones or other supporting technology, inadequate socialization and mentoring, and low education. Despite the fact that the level of education did not affect fishermen awareness in using technology, the low level of education became a particular constraint in gaining immediate comprehension on the use of the available information and communication technologies. In addition, the radius of the fishing area that was only 10 miles from the mainland. This was also a reason fishermen felt that they did not need to use sophisticated technology. Internet coverage at sea was also low. Fishermen stated that they had difficulties in accessing internet on high seas. According to stakeholders, the strategy to optimize the use of ICTs was to organize a pilot area through mentoring and modification of features in the applications, one of which was by adding features that can predict fish seasons. Thus, fishermen could use fishing gear according to the season. An overview of optimizing the use of ICTs is summarized in Figure 4.**



Source: Promary data processed, 2020

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Figure 4. Optimization in the use of information and communication technologies (ICT) in fisheries.

According to Sabu et al (2017), the adoption of ICT system tools in the fisheries sector depends on several variables such as boat size, number of crew members, fishermen education, area specifications, duration of days per trip (operational trip duration), and the distance to the fishing grounds (fishing route). Figure 4 showed that the fishermen awareness of the use of ICTs applications for fisheries was high, as presented by the opinion of fishermen about the importance of service information, 95% of the total respondents agreeing on the importance of service information. However, about 85% of fishermen had problems in the use ICTs application. The constraints experienced by fishermen were put forward by the Head of the Fishermen in Banyutowo village, who stated that fishermen wanted to use the fishermen application because it helped them to know the weather and other conditions. However, he stated that the main obstacle was that fishermen were not predisposed at learning to use the applications because it seemed complicated. He pronounced that even he himself is sometimes confused when using a cellphone and another reason is the high cost of accessing through a cellphone.

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Before going to sea, fishermen looked for information about water conditions. This was done to anticipate weather conditions when fishing in order to increase safety when sailing. Being a fisherman is a high-risk job which is highly dependent on natural conditions. The occurrence of climate variability can be in the form of shifts in rainfall, wave height, and wind speed, which can affect fishing operations (Azizi et al 2017). Information about fish catching areas is very important to be applied and in helping to overcome the problems of seizing fish catching areas and overfishing (Muhsoni et al 2009; Paul et al 2016). The response of small-scale fishermen to the existence of ICTs, as

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presented in this study, was still low, and the use of traditional methods dominated in helping fishing activities. Fishermen were aware that information about fishing locations, weather changes, and high sea waves were needed. The information technology referred to in this research was represented by BMKG, GPS, Fish Finder, television, and Windy application. Factors that affect fisheries production are season, weather, and technological advances such as the use of a GPS and Fish Finder to detect fish (Sulastri 2014). Other advances in information technology, such as fish prices in near-shore markets, will affect the stability of fishermen arrivals (Foss & Couclelis 2009).

The implementation of the fisheries information applications required a re-assessment, especially for fishermen who were on the island of Java, where there were overfishing cases from time to time. An employee of the Department of Fisheries and Marine Affairs in Central Java said that small-scale fishemen have only 12 miles of fishing radius at sea from mainland. He noted that if a fisherman found a fishing location at one point, some others would gather in groups to fish in the same point, which would cause overfishing, and this made it more suitable and profitable for boats of more than 10 GT.

Another obstacle was that fishermen did not have a definite or certain income, so they could not afford to buy supporting equipment such as GPS or mobile phones to help their fishing activities when they went to sea. Furthermore, the low level of education caused fishermen to not realize the importance of supporting ICTs in order to increase fishery production. The fishing route was also a constraint, as the small-scale fisherman could only fish in a radius of 12 miles from mainland. The fishing range also led to difficult internet signal, as the internet coverage at sea was bad. In addition, there was a high risk of taking cellphones at the sea, because fishermen thought that cellphone damage was difficult to avoid, while the cost of cellphones was high. Recommendations for increasing the application of service information were suggested by providing assistance, mentoring, and modification of service application features that are more suitable for small-scale fishermen. Some aspects that need to be accommodated to overcome development problems in the fisheries value chain are technology adoption, government intervention, environmental awareness, and fish farming organizations (Suharno et al 2017b). This is in accordance with the statement of an employee of the Marine Fisheries Office of Pati regency, PPP Bajomulyo Branch, who stated that small-scale fishermen did not use only one type of fishing gear; different seasons required different fishing gears, because the fish species would be different; the application should be completed with weather information and notifications, so that fishermen could predict what kind of fishing gears they would have to use in a certain season.

Feature adjustments in the fisheries application are needed because traditional fishermen are still confident in using traditional event modes or natural cues.

Conclusions**. The use of ICTs is now something that can no longer be avoided. Based on the results of the analysis, it can be concluded that the level of awareness of fishermen in Pati Regency was higher than in Pemalang Regency in terms of age. The level of awareness of fishermen in Pemalang Regency was higher than in Pati Regency regarding the level of education. Fishermen in the two research locations had high awareness of the importance and usefulness of ICTs in assisting fishing activities. Even so, information technology had not been widely used. Capital for technology purchases and fishermen reluctance to study the new technology were the constraints that still needed to be overcome in the use of ICTs system in the fisheries sector, especially in the northern coastal areas of Central Java, Indonesia.**

Conflict of Interest**. The authors declare that there is no conflict of interest.**

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Fishermen behavior in the use of information and communication technologies (ICTs) in Central Java Province, Indonesia: Comparative study in Pati and Pemalang regencies

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Abstract. **The fourth industrial revolution requires the readiness in the use of information and communication technologies (ICTs) for fisheries and farming in addition to the industrial sector. Moreover, climate change in the last decade leads to the development of new technologies that create tools in facilitating fishing activities. The tools do not rely on natural cues of fishing locations at sea, because fishermen awareness in using technologies should help improve fisheries products. This research combined a quantitative and qualitative approach (mixed methods), as the research purpose was to compare fisheries awareness level in the use of ICTs in two potential fishing locations in the northern coastal area of Central Java, namely Pati and Pemalang regencies. The results showed that fishermen awareness was high in the use of ICTs in the two fishing locations. The fishermen awareness**

in Pati regency was higher than in Pemalang regency based on age, while fishermen awareness in Pemalang regency was higher than in Pati regency based on the level of education. Uncertainty of income, the difficulty of internet coverage on the water, and the level of education become constraints in the use of ICTs in the fisheries sector. Accompaniment and modifications in the application features could help improve the use of ICTs in the fisheries sector.
Keywords**: climate change, fisher, ICTs, Pati, Pemalang, small scale.**

Introduction**. Information and communication technologies (ICTs) in the field of fisheries vary with the use of GPS, sonars, wireless devices, computers, internet and cellphones. ICTs are seen as being able to offer a socio-economic improvement for fishermen, simplify the communication process, and increase safety (Omar et al 2011). ICTs such as the Cloud, Internet of Things (IoT), location-based monitoring (remote sensing, geographic information and drones), and Big Data will play a key role in achieving innovative food security in the context of the digital economy (El Bilali & Allahyari 2018). The availability of information such as the distribution of fish catches, fishing gear used, and vessel size is required for proper management of plans in the management of fish catching businesses (Previero & Gasalla 2018). Information regarding fish catching areas will be very important to overcome the problems of seizing fish catching areas and overfishing areas (Simbolon et al 2011; Arifah 2018).**

Despite having abundant fishery resources, the involvement of the community, especially fishermen, will be needed in balancing the use and conservation of fishery resources (Suharno et al 2017a). Therefore, information in the form of a decision system is needed to support fishing activities and ship operations. The rapid use of information and telecommunications technology can create cost efficiency in fisheries sectors (Arifah 2018). Provision of appropriate information and technology will be of great benefit to fishermen and entrepreneurs engaged in fishing. The price information of fish is needed related to the fish price trading system, while information related to weather forecasts and sea waves is needed by fishermen because it is related to safety while sailing (Muawanah et al 2018).

Climate change that occurs due to global warming is currently having an impact on the existence of traditional fishermen who rely on natural cues to determine the location of their catch at sea. Climate change makes the situation of fishery resources vulnerable and also makes fishermen uncomfortable. Until now, many fishermen have not prepared for climate change (Hartoko et al 2010). Low level of education and difficulty in finding work aside from being fishermen, despite the relatively old age, are reasons for fishermen to continue working as fishermen (Tantra et al 2020). Therefore, the use of ICTs in the form of applications that can be used by fishermen in fishing activities is needed. The use of information system applications for fishermen will be related to the person's awareness of ICTs. Therefore, this study aimed to: (1) analyze fishermen awareness in the use of ICTs in fisheries and 2) analyze the factors that support optimizing the use of ICTs in fisheries.

Material and Method

Study sites. **This research took place in the northern coastal area of Central Java. Banyutowo village, Dukuhseti district, Pati Regency and Asem Doyong village, Pemalang Regency were selected as research locations. Pati and Pemalang regencies were chosen because they were one of the pilot project areas for the application of the Fisheries Application from the Ministry of Fisheries and Marine Affairs based on the report of Marine and Fisheries Research and Human Resources Agency - Badan Riset dan Sumber Daya Manusia Kelautan dan Perikanan - (BRSDM). Pati and Pemalang regencies were also potential fishing areas in Central Java. Even though the fishermen in the fishing areas of these regencies have used several technologies related to fishing techniques, they have not yet made use of the existing information system application. Thus, these areas were used as a pilot area with results that can be adopted by other fishermen from other fishing regions. This research was conducted from November 2019 to July 2020. The study sites are presented in Figure 1.**

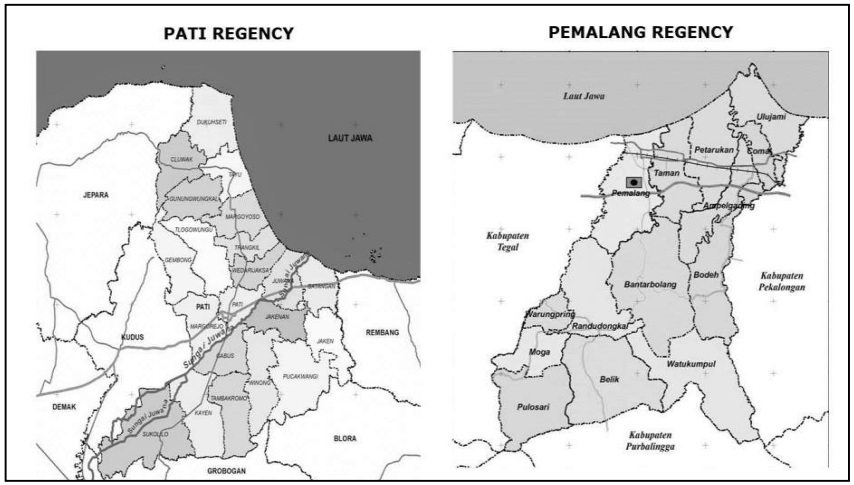

Figure 1. Study sites in Pati and Pemalang regencies, Central Java Province, Indonesia.

Method. **The method used in this study is a combination of quantitative analysis and qualitative analysis (mixed method) (Ardiansyah et al 2019; Prastyadewi et al 2020). A quantitative approach was carried out through descriptive statistics and a qualitative approach through simple triangulation with the help of the Atlas.ti program. Respondents in this study consisted of 120 fishermen, of which 60 were from Pati and 60 from Pemalang. The number of samples was double the requirements for the minimum of 30 respondents (Perneger et al 2015). It is often suggested that a sample size of 30 will produce an approximately normal sampling distribution for the sample mean from a non-normal parent distribution (Islam 2018). Respondents were interviewed using a structured questionnaire for the quantitative analysis accompanied by in-depth interviews to obtain a clearer picture for qualitative analysis to support the research results. In-depth interviews were conducted with 12 key persons. Sampling of respondents was done by using the purposive sampling method. Key persons in this study were elements of A-B-G-C, which include academics, business people, the Fisheries and Marine Service of Pati and Pemalang regencies, the Department of Marine Affairs and Fisheries of Central Java Province, as well as the Head of Fishermen Groups.**

Results and Discussion

Fishermen characteristics. **Fishermen in Banyutowo and Asemdoyong village were small-scale fishermen, with a boat size with the average size of 10 gross ton (GT). This characteristic was related to the testing purposes of the Ministry of Fisheries and Marine Affairs which stated that ICTs testing should be conducted only by small-scale fishermen, with 10 GT boats (Ministry of Fisheries and Marine Affairs, 2019). The fishermen characteristics from respondents can be seen in Table 1.**

Table 1

Fishermen characteristics

Variable		*Pati Regency*		*Pemalang Regency*	
		F	*(%)*	*F*	*(%)*
Boat size (GT)	<5 GT	49	81.7	3	5
	5-10 GT	11	18.3	43	71.7
	>10 GT	0	0	14	23.3
Operational trip duration (days)	< 1 days	34	56.7	19	31.7
	1-3 days	15	25	33	55
	4-6 days	11	18.3	8	13.3
Fish catching route (km)	0-2 km	9	15	6	10
	2-4 km	7	11.7	12	20
	5–12 km	27	45	33	55
	>12 km	17	10.2	9	15

Note: F - frequency.

Table 1 shows the characteristics of fishermen in Banyutowo village, Pati Regency and Asemdoyo village, Pemalang Regency. Based on the boat size characteristic, the majority of fishermen in Pati Regency owned boats with a size of less than 5 GT (81.7%), while the rest owned boats with a size of 5-10 GT. Meanwhile, the majority of fishermen in Pemalang Regency owned boats with a size of 5-10 GT (71.7%), while the rest owned boats with a size of more than 10 GT (23.3%).

The duration of the operational fishing trip was calculated based on the number of days the fishermen were at sea. The data showed that, in both Pati and Pemalang regencies, fishermen had an average operational trip duration of 1-3 days. Operational trip duration was supported by the size of the fishing boat. Meanwhile, when the characteristics of the fish catching route were compiled, fishermen from both locations had a range of less than 12 miles. The bigger the size of the boat with more storage space and supplies allowed the ship to travel longer and have a better reach. On the other hand, a boat with a small size was able to accommodate only a limited number of supplies, so that it would have limited operational time and a closer fish catching range. The description of the fish catching areas for Pati and Pemalang regencies is illustrated in Figure 2.

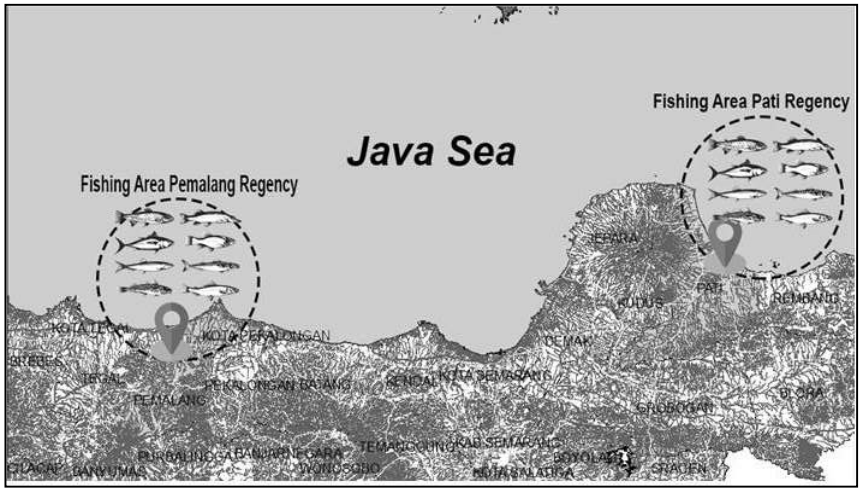

Figure 2. Fish catching areas in Pati and Pemalang regencies.

Socio-economical characteristics of fishermen. **The socio-economical characteristics of fishermen in Banyutowo village, Pati Regency and Asemdoyo village, Pemalang Regency were described in the variables of age, level of education, and income. Table 2 shows the socio-economical characteristics of respondents.**

Table 2

Socio-economical characteristics of fishermen

Variable		*Pati Regency*		*Pemalang Regency*	
		F	*(%)*	*F*	*(%)*
Age (years)	**<30**	**0**	**0**	**5**	**8.3**
	30–40	**21**	**35**	**28**	**46.7**
	41–50	**23**	**38.3**	**20**	**33.3**
	>50	**16**	**26.7**	**7**	**11.7**
Level of education	**0**	**1**	**1.7**	**5**	**8.3**
	1-6	**39**	**65.0**	**40**	**66.7**
	7-9	**10**	**16.7**	**12**	**20**
	10-12	**10**	**16.7**	**3**	**5**
Income per fishing trip	**<12 USD**	**17**	**28.3**	**20**	**33.3**

12–14 USD	20	33.3	31	51.7
>14 USD	23	38.4	9	15

Note: F - frequency.

Table 2 shows a summary of the socio-economical characteristics of fishermen at the research locations. The age range of respondents in Pati and Pemalang regencies was mostly between the ages of 30 to 50 years. This showed that fishermen were at a productive age. The level of general knowledge of fishermen was low, indicated by the 1-6 classes level of education, 65% in Pati and 66.7% in Pemalang. This showed that fishermen in the two study locations only completed basic education. Meanwhile, based on the income of fishermen, the results of the survey showed that the highest income of fishermen in Pati was 25 USD per trip, while the highest income of fishermen in Pemalang was 32 USD per trip.

Fishermen awareness in the use of information and communication technologies (ICTs). ICTs in this study represents the use of information from BMKG, GPS, Fish Finder, television, and Windy application. The summary of fishermen perception toward ICTs of fisheries can be seen in Table 3.

Table 3

Fishermen perception in fisheries information

Indicator of perception	*Pati Regency*		*Pemalang Regency*	
	F	*(%)*	*F*	*(%)*
Checking the condition of the sea weather and water information before going to the sea	33	82.5	54	90
Conformity of information with the real condition	33	82.5	40	66.7
The importance of fisheries information	38	95	52	86.7
The use of ICTs in fisheries	6	15	9	15
Constraints in the use of ICTs in fisheries	32	80	38	63.3
The pretension to access ICTs in fisheries	30	75	44	73.3
Mean	71.7%		65.8%	

Note: ICT - information and communication technology; F - frequency.

Table 3 shows the fishermen indicator of perception regarding fisheries information in Pati and Pemalang regencies. The data showed that fishermen had on average high perceptions of fisheries information. Based on the indicators, it can be seen that the fishermen perception of the importance of fisheries information in Pati Regency had the highest percentage, 95%. Meanwhile, for Pemalang, the highest indicator was information on the state of the waters and sea weather before going to sea, 90%. Fishermen awareness in the use of ICT systems had the lowest percentage in both Pati and Pemalang regencies. The information obtained also showed that fishermen in the two research locations had high obstacles or constraints in the use of ICTs systems, even though they had a high pretension to access the sea information from ICT systems.

Information related to the type of ICTs used by fishermen in both research locations is described in Figure 3.

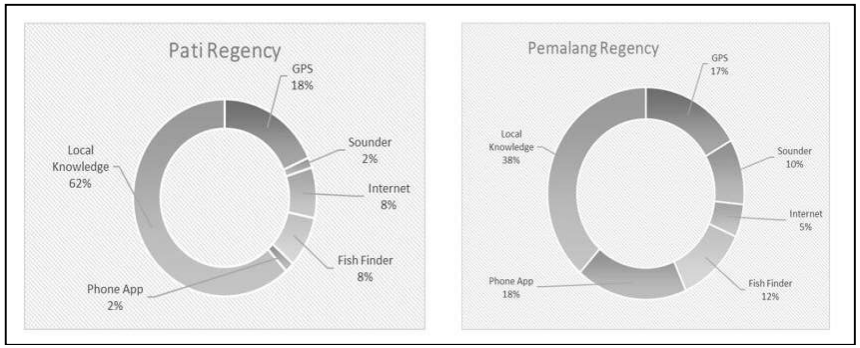

Figure 3. Information and communication technologies used by fishermen when sailing.

Figure 3 shows the types of ICT used by fishermen when fishing. From the total respondents in Pati, 62% used the determination of fishing locations and information on weather conditions in the traditional way, following natural cues. Meanwhile, respondents in Pemalang who still used natural cues or local knowledge were 38% of the total respondents. This was due to the perception of fishermen who stated that natural cues could still describe weather conditions at sea. The use of traditional methods was still relevant to catch fish and for other reasons which were further explained through triangulation analysis using the Atlas.ti software. The traditional way to find information by reading natural cues was the most common practice among respondents in both Pati and Pemalang.

The analysis showed that 18% of respondents in Pati and 17% of respondents in Pemalang used GPS as a tool for fishing. 8% of respondents in Pati and 12% of respondents in Pemalang used fish finder. 2% of respondents in Pati and 10% of respondents in Pemalang used sounders/fish finders. 8% of respondents in Pati regency and 5% of respondents in Pemalang regency had been looking for information on the internet based on data from BMKG. The ICT systems in the form of a software application were mostly used by respondents in Pemalang that was 18% of the respondents, while in Pati Regency it was only 2%. From this information, it means that respondents in Pemalang had higher digital literacy in technology than respondents in Pati.

Table 4

Crosstab of age and education to the level of awareness in the use of information and communication technologies

Variable		*Level of awareness*							
		Pati Regency				*Pemalang Regency*			
		L	M	H	Total	L	M	H	Total
Age	<30	0	0	0	0	0	2	3	5
	30-40	0	5	16	21	7	4	17	28
	41-50	4	5	14	23	6	3	11	20
	>50	6	5	5	16	5	2	0	7

	Total	10	15	35	60	18	11	31	60
Education	0	1	0	0	1	3	1	1	5
	1-6	8	14	17	39	6	10	23	39
	7-9	1	2	7	10	1	2	10	13
	10-12	0	3	7	10	0	0	3	3
	Total	10	19	31	60	10	13	37	60

Note: L - low; M - moderate; H - high.

Table 4 shows the level of awareness of fishermen in the use of ICTs in Pati and Pemalang. 35 fishermen in Pati and 31 fishermen in Pemalang had high level of awareness in using ICTs in terms of age. 31 fishermen in Pati and 37 fishermen in Pemalang had high level of awareness in using ICTs based on the level of education. This showed that most fishermen cared about the importance of ICTs for fishing activities. The majority of respondents who had a low level of education turned out to have a high level of awareness of using ICTs in both Pati and Pemalang regencies. Thus, the level of education of fishermen should not be an obstacle or constraint in implementing the use of service ICTs. It only takes training and mentoring to achieve the fourth industrial revolution in the fisheries sector.

Rudiawan et al (2012) state that the use of information systems can change the way fishermen work. The use of a technology system in the form of Potential Fishing Zone (PFZ) - "Zona Potensi Penangkapan Ikan" (ZPPI) - maps must still be accompanied by training on how to read maps and navigation technology or GPS. Android-based information systems are very useful for fishermen, both for the fishing process and for marketing their catch. As pointed out by Chhachhar & Omar (2012), fishermen can get the latest information about the weather and can also save time by using cell phones. Mobile cellphones give fishermen the option to reduce risk, especially in emergency situations when they are at sea.

Factors supporting the optimization of using ICTs. Based on the results of in-depth interviews, the constraints in using ICTs at the research locations were the uncertainty of income which caused the inability to buy smart phones or other supporting technology, inadequate socialization and mentoring, and low education. Despite the fact that the level of education did not affect fishermen awareness in using technology, the low level of education became a particular constraint in gaining immediate comprehension on the use of the available information and communication technologies. In addition, the radius of the fishing area that was only 10 miles from the mainland. This was also a reason fishermen felt that they did not need to use sophisticated technology. Internet coverage at sea was also low. Fishermen stated that they had difficulties in accessing internet on high seas. According to stakeholders, the strategy to optimize the use of ICTs was to organize a pilot area through mentoring and modification of features in the applications, one of which was by adding features that can predict fish seasons. Thus, fishermen could use fishing gear according to the season. An overview of optimizing the use of ICTs is summarized in Figure 4.

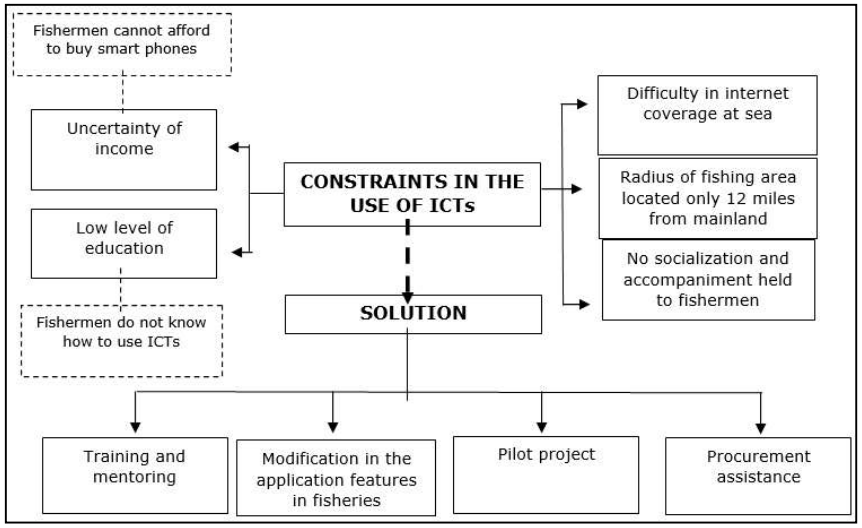

Figure 4. Optimization in the use of information and communication technologies (ICT) in fisheries.

According to Sabu et al (2017), the adoption of ICT system tools in the fisheries sector depends on several variables such as boat size, number of crew members, fishermen education, area specifications, duration of days per trip (operational trip duration), and the distance to the fishing grounds (fishing route). Figure 4 showed that the fishermen awareness of the use of ICTs applications for fisheries was high, as presented by the opinion of fishermen about the importance of service information, 95% of the total respondents agreeing on the importance of service information. However, about 85% of fishermen had problems in the use ICTs application. The constraints experienced by fishermen were put forward by the Head of the Fishermen in Banyutowo village, who stated that fishermen wanted to use the fishermen application because it helped them to know the weather and other conditions. However, he stated that the main obstacle was that fishermen were not predisposed at learning to use the applications because it seemed complicated. He pronounced that even he himself is sometimes confused when using a cellphone and another reason is the high cost of accessing through a cellphone.

Before going to sea, fishermen looked for information about water conditions. This was done to anticipate weather conditions when fishing in order to increase safety when sailing. Being a fisherman is a high-risk job which is highly dependent on natural conditions. The occurrence of climate variability can be in the form of shifts in rainfall, wave height, and wind speed, which can affect fishing operations (Azizi et al 2017). Information about fish catching areas is very important to be applied and in helping to overcome the problems of seizing fish catching areas and overfishing (Muhsoni et al 2009; Paul et al 2016). The response of small-scale fishermen to the existence of ICTs, as presented in this study, was still low, and the use of traditional methods dominated in helping fishing activities. Fishermen were aware that information about fishing locations, weather changes, and high sea waves were needed. The information technology referred to in this research was represented by BMKG, GPS, Fish Finder, television, and Windy application. Factors that affect fisheries production are season, weather, and technological advances

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such as the use of a GPS and Fish Finder to detect fish (Sulastri *et al,* 2014). Other advances in information technology, such as fish prices in near-shore markets, will affect the stability of fishermen arrivals (Foss & Couclelis 2009).

The implementation of the fisheries information applications required a re-assessment, especially for fishermen who were on the island of Java, where there were overfishing cases from time to time. An employee of the Department of Fisheries and Marine Affairs in Central Java said that small-scale fishemen have only 12 miles of fishing radius at sea from mainland. He noted that if a fisherman found a fishing location at one point, some others would gather in groups to fish in the same point, which would cause overfishing, and this made it more suitable and profitable for boats of more than 10 GT.

Another obstacle was that fishermen did not have a definite or certain income, so they could not afford to buy supporting equipment such as GPS or mobile phones to help their fishing activities when they went to sea. Furthermore, the low level of education caused fishermen to not realize the importance of supporting ICTs in order to increase fishery production. The fishing route was also a constraint, as the small-scale fisherman could only fish in a radius of 12 miles from mainland. The fishing range also led to difficult internet signal, as the internet coverage at sea was bad. In addition, there was a high risk of taking cellphones at the sea, because fishermen thought that cellphone damage was difficult to avoid, while the cost of cellphones was high. Recommendations for increasing the application of service information were suggested by providing assistance, mentoring, and modification of service application features that are more suitable for small-scale fishermen. Some aspects that need to be accommodated to overcome development problems in the fisheries value chain are technology adoption, government intervention, environmental awareness, and fish farming organizations (Suharno et al 2017b). This is in accordance with the statement of an employee of the Marine Fisheries Office of Pati regency, PPP Bajomulyo Branch, who stated that small-scale fishermen did not use only one type of fishing gear; different seasons required different fishing gears, because the fish species would be different; the application should be completed with weather information and notifications, so that fishermen could predict what kind of fishing gears they would have to use in a certain season.

Feature adjustments in the fisheries application are needed because traditional fishermen are still confident in using traditional event modes or natural cues.

Conclusions**. The use of ICTs is now something that can no longer be avoided. Based on the results of the analysis, it can be concluded that the level of awareness of fishermen in Pati Regency was higher than in Pemalang Regency in terms of age. The level of awareness of fishermen in Pemalang Regency was higher than in Pati Regency regarding the level of education. Fishermen in the two research locations had high awareness of the importance and usefulness of ICTs in assisting fishing activities. Even so, information technology had not been widely used. Capital for technology purchases and fishermen reluctance to study the new technology were the constraints that still needed to be overcome in the use of ICTs system in the fisheries sector, especially in the northern coastal areas of Central Java, Indonesia.**

Conflict of Interest**. The authors declare that there is no conflict of interest.**

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Fishermen behavior in the use of information and communication technologies (ICTs) in Central Java Province, Indonesia: Comparative study in Pati and Pemalang regencies

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Abstract. **The fourth industrial revolution requires the readiness in the use of information and communication technologies (ICTs) for fisheries and farming in addition to the industrial sector. Moreover, climate change in the last decade leads to the development of new technologies that create tools in facilitating fishing activities. The tools do not rely on natural cues of fishing locations at sea, because fishermen awareness in using technologies should help improve fisheries products. This research combined a quantitative and qualitative approach (mixed methods), as the research purpose was to compare fisheries awareness level in the use of ICTs in two potential fishing locations in the northern coastal area of Central Java, namely Pati and Pemalang regencies. The results showed that fishermen awareness was high in the use of ICTs in the two fishing locations. The fishermen awareness**

in Pati regency was higher than in Pemalang regency based on age, while fishermen awareness in Pemalang regency was higher than in Pati regency based on the level of education. Uncertainty of income, the difficulty of internet coverage on the water, and the level of education become constraints in the use of ICTs in the fisheries sector. Accompaniment and modifications in the application features could help improve the use of ICTs in the fisheries sector.
Keywords**: climate change, fisher, ICTs, Pati, Pemalang, small scale.**

Introduction**. Information and communication technologies (ICTs) in the field of fisheries vary with the use of GPS, sonars, wireless devices, computers, internet and cellphones. ICTs are seen as being able to offer a socio-economic improvement for fishermen, simplify the communication process, and increase safety (Omar et al 2011). ICTs such as the Cloud, Internet of Things (IoT), location-based monitoring (remote sensing, geographic information and drones), and Big Data will play a key role in achieving innovative food security in the context of the digital economy (El Bilali & Allahyari 2018). The availability of information such as the distribution of fish catches, fishing gear used, and vessel size is required for proper management of plans in the management of fish catching businesses (Previero & Gasalla 2018). Information regarding fish catching areas will be very important to overcome the problems of seizing fish catching areas and overfishing areas (Simbolon et al 2011; Arifah 2018).**

Despite having abundant fishery resources, the involvement of the community, especially fishermen, will be needed in balancing the use and conservation of fishery resources (Suharno et al 2017a). Therefore, information in the form of a decision system is needed to support fishing activities and ship operations. The rapid use of information and telecommunications technology can create cost efficiency in fisheries sectors (Arifah 2018). Provision of appropriate information and technology will be of great benefit to fishermen and entrepreneurs engaged in fishing. The price information of fish is needed related to the fish price trading system, while information related to weather forecasts and sea waves is needed by fishermen because it is related to safety while sailing (Muawanah et al 2018).

Climate change that occurs due to global warming is currently having an impact on the existence of traditional fishermen who rely on natural cues to determine the location of their catch at sea. Climate change makes the situation of fishery resources vulnerable and also makes fishermen uncomfortable. Until now, many fishermen have not prepared for climate change (Hartoko et al 2010). Low level of education and difficulty in finding work aside from being fishermen, despite the relatively old age, are reasons for fishermen to continue working as fishermen (Tantra et al 2020). Therefore, the use of ICTs in the form of applications that can be used by fishermen in fishing activities is needed. The use of information system applications for fishermen will be related to the person's awareness of ICTs. Therefore, this study aimed to: (1) analyze fishermen awareness in the use of ICTs in fisheries and 2) analyze the factors that support optimizing the use of ICTs in fisheries.

Material and Method

*Study sites***. This research took place in the northern coastal area of Central Java. Banyutowo village, Dukuhseti district, Pati Regency and Asem Doyong village, Pemalang Regency were selected as research locations. Pati and Pemalang regencies were chosen because they were one of the pilot project areas for the application of the Fisheries Application from the Ministry of Fisheries and Marine Affairs based on the report of Marine and Fisheries Research and Human Resources Agency - Badan Riset dan Sumber Daya Manusia Kelautan dan Perikanan - (BRSDM). Pati and Pemalang regencies were also potential fishing areas in Central Java. Even though the fishermen in the fishing areas of these regencies have used several technologies related to fishing techniques, they have not yet made use of the existing information system application. Thus, these areas were used as a pilot area with results that can be adopted by other fishermen from other fishing regions. This research was conducted from November 2019 to July 2020. The study sites are presented in Figure 1.**

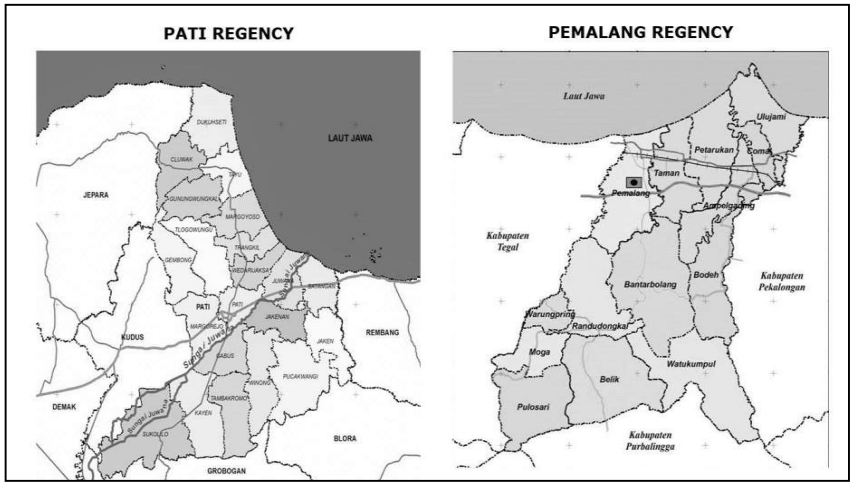

Figure 1. Study sites in Pati and Pemalang regencies, Central Java Province, Indonesia.

Method. **The method used in this study is a combination of quantitative analysis and qualitative analysis (mixed method) (Ardiansyah et al 2019; Prastyadewi et al 2020). A quantitative approach was carried out through descriptive statistics and a qualitative approach through simple triangulation with the help of the Atlas.ti program. Respondents in this study consisted of 120 fishermen, of which 60 were from Pati and 60 from Pemalang. The number of samples was double the requirements for the minimum of 30 respondents (Perneger et al 2015). It is often suggested that a sample size of 30 will produce an approximately normal sampling distribution for the sample mean from a non-normal parent distribution (Islam 2018). Respondents were interviewed using a structured questionnaire for the quantitative analysis accompanied by in-depth interviews to obtain a clearer picture for qualitative analysis to support the research results. In-depth interviews were conducted with 12 key persons. Sampling of respondents was done by using the purposive sampling method. Key persons in this study were elements of A-B-G-C, which include academics, business people, the Fisheries and Marine Service of Pati and Pemalang regencies, the Department of Marine Affairs and Fisheries of Central Java Province, as well as the Head of Fishermen Groups.**

Results and Discussion

Fishermen characteristics. **Fishermen in Banyutowo and Asemdoyong village were small-scale fishermen, with a boat size with the average size of 10 gross ton (GT). This characteristic was related to the testing purposes of the Ministry of Fisheries and Marine Affairs which stated that ICTs testing should be conducted only by small-scale fishermen, with 10 GT boats (Ministry of Fisheries and Marine Affairs, 2019). The fishermen characteristics from respondents can be seen in Table 1.**

Table 1

Fishermen characteristics

Variable		*Pati Regency*		*Pemalang Regency*	
		F	*(%)*	*F*	*(%)*
Boat size (GT)	<5 GT	49	81.7	3	5
	5-10 GT	11	18.3	43	71.7
	>10 GT	0	0	14	23.3
Operational trip duration (days)	< 1 days	34	56.7	19	31.7
	1-3 days	15	25	33	55
	4-6 days	11	18.3	8	13.3
Fish catching route (km)	0-2 km	9	15	6	10
	2-4 km	7	11.7	12	20
	5–12 km	27	45	33	55
	>12 km	17	10.2	9	15

Note: F - frequency.

Table 1 shows the characteristics of fishermen in Banyutowo village, Pati Regency and Asemdoyo village, Pemalang Regency. Based on the boat size characteristic, the majority of fishermen in Pati Regency owned boats with a size of less than 5 GT (81.7%), while the rest owned boats with a size of 5-10 GT. Meanwhile, the majority of fishermen in Pemalang Regency owned boats with a size of 5-10 GT (71.7%), while the rest owned boats with a size of more than 10 GT (23.3%).

The duration of the operational fishing trip was calculated based on the number of days the fishermen were at sea. The data showed that, in both Pati and Pemalang regencies, fishermen had an average operational trip duration of 1-3 days. Operational trip duration was supported by the size of the fishing boat. Meanwhile, when the characteristics of the fish catching route were compiled, fishermen from both locations had a range of less than 12 miles. The bigger the size of the boat with more storage space and supplies allowed the ship to travel longer and have a better reach. On the other hand, a boat with a small size was able to accommodate only a limited number of supplies, so that it would have limited operational time and a closer fish catching range. The description of the fish catching areas for Pati and Pemalang regencies is illustrated in Figure 2.

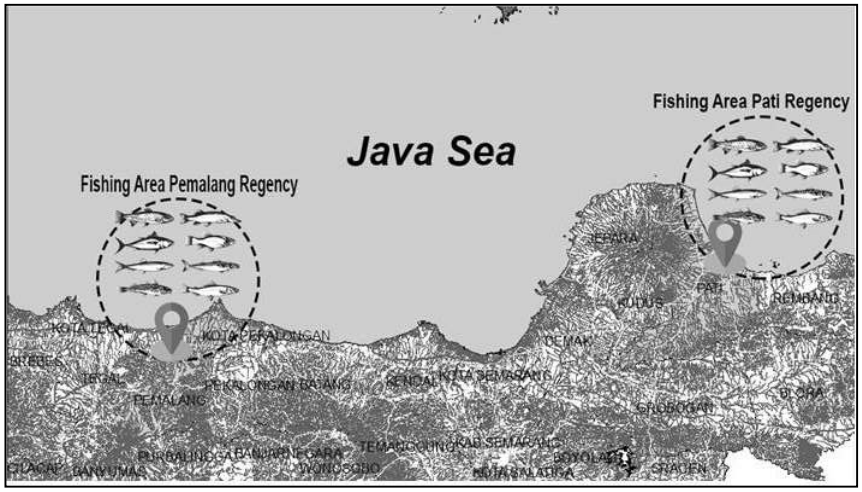

Figure 2. Fish catching areas in Pati and Pemalang regencies.

Socio-economical characteristics of fishermen. **The socio-economical characteristics of fishermen in Banyutowo village, Pati Regency and Asemdoyo village, Pemalang Regency were described in the variables of age, level of education, and income. Table 2 shows the socio-economical characteristics of respondents.**

Table 2

Socio-economical characteristics of fishermen

Variable		*Pati Regency*		*Pemalang Regency*	
		F	*(%)*	*F*	*(%)*
Age (years)	**<30**	**0**	**0**	**5**	**8.3**
	30–40	**21**	**35**	**28**	**46.7**
	41–50	**23**	**38.3**	**20**	**33.3**
	>50	**16**	**26.7**	**7**	**11.7**
Level of education	**0**	**1**	**1.7**	**5**	**8.3**
	1-6	**39**	**65.0**	**40**	**66.7**
	7-9	**10**	**16.7**	**12**	**20**
	10-12	**10**	**16.7**	**3**	**5**
Income per fishing trip	**<12 USD**	**17**	**28.3**	**20**	**33.3**

12–14 USD	20	33.3	31	51.7
>14 USD	23	38.4	9	15

Note: F - frequency.

Table 2 shows a summary of the socio-economical characteristics of fishermen at the research locations. The age range of respondents in Pati and Pemalang regencies was mostly between the ages of 30 to 50 years. This showed that fishermen were at a productive age. The level of general knowledge of fishermen was low, indicated by the 1-6 classes level of education, 65% in Pati and 66.7% in Pemalang. This showed that fishermen in the two study locations only completed basic education. Meanwhile, based on the income of fishermen, the results of the survey showed that the highest income of fishermen in Pati was 25 USD per trip, while the highest income of fishermen in Pemalang was 32 USD per trip.

Fishermen awareness in the use of information and communication technologies (ICTs). ICTs in this study represents the use of information from BMKG, GPS, Fish Finder, television, and Windy application. The summary of fishermen perception toward ICTs of fisheries can be seen in Table 3.

Table 3

Fishermen perception in fisheries information

Indicator of perception	*Pati Regency*		*Pemalang Regency*	
	F	*(%)*	*F*	*(%)*
Checking the condition of the sea weather and water information before going to the sea	33	82.5	54	90
Conformity of information with the real condition	33	82.5	40	66.7
The importance of fisheries information	38	95	52	86.7
The use of ICTs in fisheries	6	15	9	15
Constraints in the use of ICTs in fisheries	32	80	38	63.3
The pretension to access ICTs in fisheries	30	75	44	73.3
Mean	71.7%		65.8%	

Note: ICT - information and communication technology; F - frequency.

Table 3 shows the fishermen indicator of perception regarding fisheries information in Pati and Pemalang regencies. The data showed that fishermen had on average high perceptions of fisheries information. Based on the indicators, it can be seen that the fishermen perception of the importance of fisheries information in Pati Regency had the highest percentage, 95%. Meanwhile, for Pemalang, the highest indicator was information on the state of the waters and sea weather before going to sea, 90%. Fishermen awareness in the use of ICT systems had the lowest percentage in both Pati and Pemalang regencies. The information obtained also showed that fishermen in the two research locations had high obstacles or constraints in the use of ICTs systems, even though they had a high pretension to access the sea information from ICT systems.

Information related to the type of ICTs used by fishermen in both research locations is described in Figure 3.

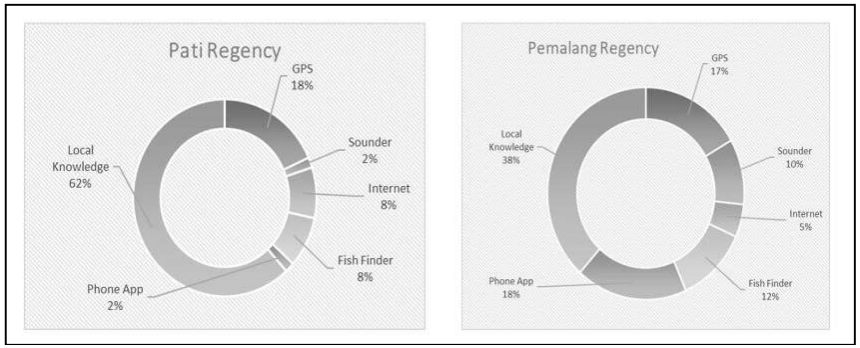

Figure 3. Information and communication technologies used by fishermen when sailing.

Figure 3 shows the types of ICT used by fishermen when fishing. From the total respondents in Pati, 62% used the determination of fishing locations and information on weather conditions in the traditional way, following natural cues. Meanwhile, respondents in Pemalang who still used natural cues or local knowledge were 38% of the total respondents. This was due to the perception of fishermen who stated that natural cues could still describe weather conditions at sea. The use of traditional methods was still relevant to catch fish and for other reasons which were further explained through triangulation analysis using the Atlas.ti software. The traditional way to find information by reading natural cues was the most common practice among respondents in both Pati and Pemalang.

The analysis showed that 18% of respondents in Pati and 17% of respondents in Pemalang used GPS as a tool for fishing. 8% of respondents in Pati and 12% of respondents in Pemalang used fish finder. 2% of respondents in Pati and 10% of respondents in Pemalang used sounders/fish finders. 8% of respondents in Pati regency and 5% of respondents in Pemalang regency had been looking for information on the internet based on data from BMKG. The ICT systems in the form of a software application were mostly used by respondents in Pemalang that was 18% of the respondents, while in Pati Regency it was only 2%. From this information, it means that respondents in Pemalang had higher digital literacy in technology than respondents in Pati.

Table 4

Crosstab of age and education to the level of awareness in the use of information and communication technologies

Variable		*Level of awareness*							
		Pati Regency				*Pemalang Regency*			
		L	M	H	Total	L	M	H	Total
Age	<30	0	0	0	0	0	2	3	5
	30-40	0	5	16	21	7	4	17	28
	41-50	4	5	14	23	6	3	11	20
	>50	6	5	5	16	5	2	0	7

	Total	10	15	35	60	18	11	31	60
Education	0	1	0	0	1	3	1	1	5
	1-6	8	14	17	39	6	10	23	39
	7-9	1	2	7	10	1	2	10	13
	10-12	0	3	7	10	0	0	3	3
	Total	10	19	31	60	10	13	37	60

Note: L - low; M - moderate; H - high.

Table 4 shows the level of awareness of fishermen in the use of ICTs in Pati and Pemalang. 35 fishermen in Pati and 31 fishermen in Pemalang had high level of awareness in using ICTs in terms of age. 31 fishermen in Pati and 37 fishermen in Pemalang had high level of awareness in using ICTs based on the level of education. This showed that most fishermen cared about the importance of ICTs for fishing activities. The majority of respondents who had a low level of education turned out to have a high level of awareness of using ICTs in both Pati and Pemalang regencies. Thus, the level of education of fishermen should not be an obstacle or constraint in implementing the use of service ICTs. It only takes training and mentoring to achieve the fourth industrial revolution in the fisheries sector.

Rudiawan et al (2012) state that the use of information systems can change the way fishermen work. The use of a technology system in the form of Potential Fishing Zone (PFZ) - "Zona Potensi Penangkapan Ikan" (ZPPI) - maps must still be accompanied by training on how to read maps and navigation technology or GPS. Android-based information systems are very useful for fishermen, both for the fishing process and for marketing their catch. As pointed out by Chhachhar & Omar (2012), fishermen can get the latest information about the weather and can also save time by using cell phones. Mobile cellphones give fishermen the option to reduce risk, especially in emergency situations when they are at sea.

Factors supporting the optimization of using ICTs. Based on the results of in-depth interviews, the constraints in using ICTs at the research locations were the uncertainty of income which caused the inability to buy smart phones or other supporting technology, inadequate socialization and mentoring, and low education. Despite the fact that the level of education did not affect fishermen awareness in using technology, the low level of education became a particular constraint in gaining immediate comprehension on the use of the available information and communication technologies. In addition, the radius of the fishing area that was only 10 miles from the mainland. This was also a reason fishermen felt that they did not need to use sophisticated technology. Internet coverage at sea was also low. Fishermen stated that they had difficulties in accessing internet on high seas. According to stakeholders, the strategy to optimize the use of ICTs was to organize a pilot area through mentoring and modification of features in the applications, one of which was by adding features that can predict fish seasons. Thus, fishermen could use fishing gear according to the season. An overview of optimizing the use of ICTs is summarized in Figure 4.

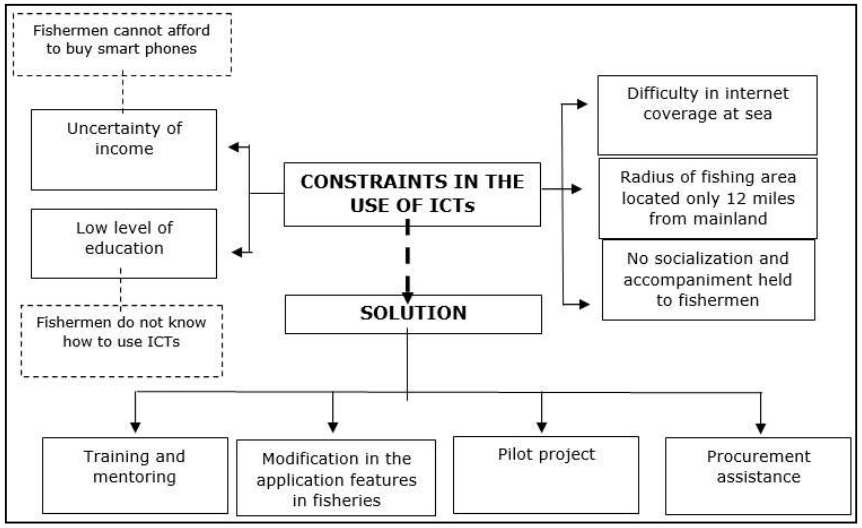

Figure 4. Optimization in the use of information and communication technologies (ICT) in fisheries.

According to Sabu et al (2017), the adoption of ICT system tools in the fisheries sector depends on several variables such as boat size, number of crew members, fishermen education, area specifications, duration of days per trip (operational trip duration), and the distance to the fishing grounds (fishing route). Figure 4 showed that the fishermen awareness of the use of ICTs applications for fisheries was high, as presented by the opinion of fishermen about the importance of service information, 95% of the total respondents agreeing on the importance of service information. However, about 85% of fishermen had problems in the use ICTs application. The constraints experienced by fishermen were put forward by the Head of the Fishermen in Banyutowo village, who stated that fishermen wanted to use the fishermen application because it helped them to know the weather and other conditions. However, he stated that the main obstacle was that fishermen were not predisposed at learning to use the applications because it seemed complicated. He pronounced that even he himself is sometimes confused when using a cellphone and another reason is the high cost of accessing through a cellphone.

Before going to sea, fishermen looked for information about water conditions. This was done to anticipate weather conditions when fishing in order to increase safety when sailing. Being a fisherman is a high-risk job which is highly dependent on natural conditions. The occurrence of climate variability can be in the form of shifts in rainfall, wave height, and wind speed, which can affect fishing operations (Azizi et al 2017). Information about fish catching areas is very important to be applied and in helping to overcome the problems of seizing fish catching areas and overfishing (Muhsoni et al 2009; Paul et al 2016). The response of small-scale fishermen to the existence of ICTs, as presented in this study, was still low, and the use of traditional methods dominated in helping fishing activities. Fishermen were aware that information about fishing locations, weather changes, and high sea waves were needed. The information technology referred to in this research was represented by BMKG, GPS, Fish Finder, television, and Windy application. Factors that affect fisheries production are season, weather, and technological advances

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such as the use of a GPS and Fish Finder to detect fish (Sulastri *et al,* 2014). Other advances in information technology, such as fish prices in near-shore markets, will affect the stability of fishermen arrivals (Foss & Couclelis 2009).

The implementation of the fisheries information applications required a re-assessment, especially for fishermen who were on the island of Java, where there were overfishing cases from time to time. An employee of the Department of Fisheries and Marine Affairs in Central Java said that small-scale fishemen have only 12 miles of fishing radius at sea from mainland. He noted that if a fisherman found a fishing location at one point, some others would gather in groups to fish in the same point, which would cause overfishing, and this made it more suitable and profitable for boats of more than 10 GT.

Another obstacle was that fishermen did not have a definite or certain income, so they could not afford to buy supporting equipment such as GPS or mobile phones to help their fishing activities when they went to sea. Furthermore, the low level of education caused fishermen to not realize the importance of supporting ICTs in order to increase fishery production. The fishing route was also a constraint, as the small-scale fisherman could only fish in a radius of 12 miles from mainland. The fishing range also led to difficult internet signal, as the internet coverage at sea was bad. In addition, there was a high risk of taking cellphones at the sea, because fishermen thought that cellphone damage was difficult to avoid, while the cost of cellphones was high. Recommendations for increasing the application of service information were suggested by providing assistance, mentoring, and modification of service application features that are more suitable for small-scale fishermen. Some aspects that need to be accommodated to overcome development problems in the fisheries value chain are technology adoption, government intervention, environmental awareness, and fish farming organizations (Suharno et al 2017b). This is in accordance with the statement of an employee of the Marine Fisheries Office of Pati regency, PPP Bajomulyo Branch, who stated that small-scale fishermen did not use only one type of fishing gear; different seasons required different fishing gears, because the fish species would be different; the application should be completed with weather information and notifications, so that fishermen could predict what kind of fishing gears they would have to use in a certain season.

Feature adjustments in the fisheries application are needed because traditional fishermen are still confident in using traditional event modes or natural cues.

Conclusions**. The use of ICTs is now something that can no longer be avoided. Based on the results of the analysis, it can be concluded that the level of awareness of fishermen in Pati Regency was higher than in Pemalang Regency in terms of age. The level of awareness of fishermen in Pemalang Regency was higher than in Pati Regency regarding the level of education. Fishermen in the two research locations had high awareness of the importance and usefulness of ICTs in assisting fishing activities. Even so, information technology had not been widely used. Capital for technology purchases and fishermen reluctance to study the new technology were the constraints that still needed to be overcome in the use of ICTs system in the fisheries sector, especially in the northern coastal areas of Central Java, Indonesia.**

Conflict of Interest**. The authors declare that there is no conflict of interest.**

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