



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

¹Sumarjianto B. M. Nugroho, ¹Indah Susilowati, ²Mudjahirin Thohir, ³Made I. Prastyadewi, ¹Ika 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 Denpasar University, Indonesia. Corresponding author: S. B. M. Nugroho, nugroho.sbm@gmail.com

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.

Key Words: 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.

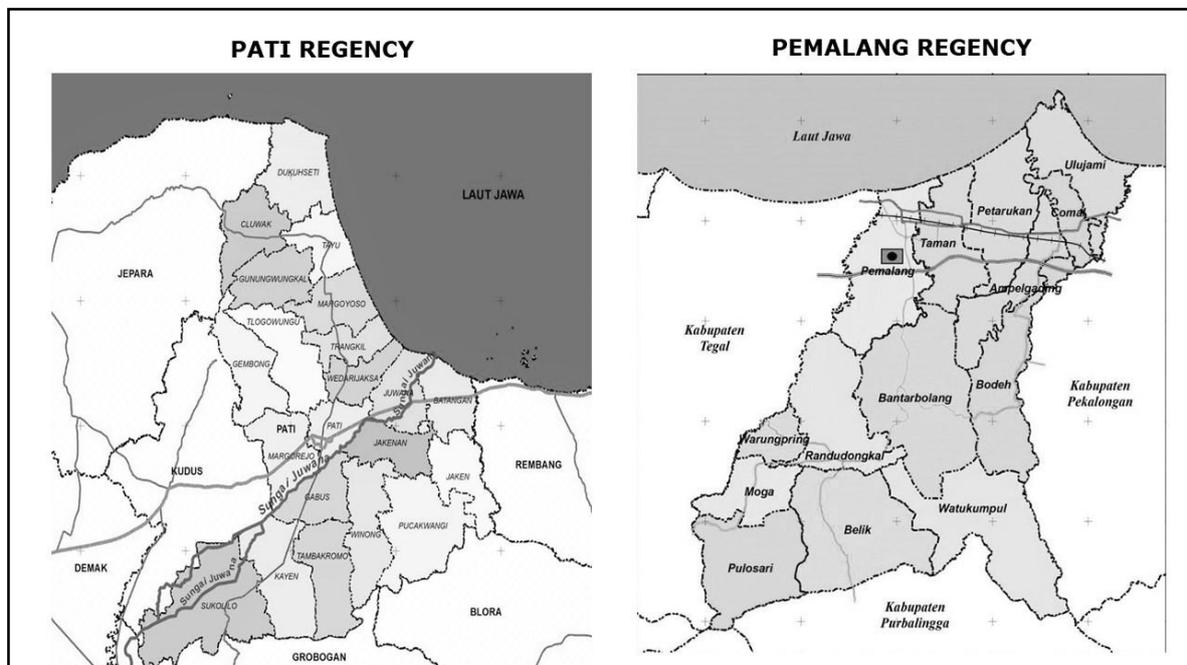


Figure 1. Study sites in Pati and Pemalang regencies, Central Java Province, Indonesia.

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 Asemdayong 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 Asemdayo 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.

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.

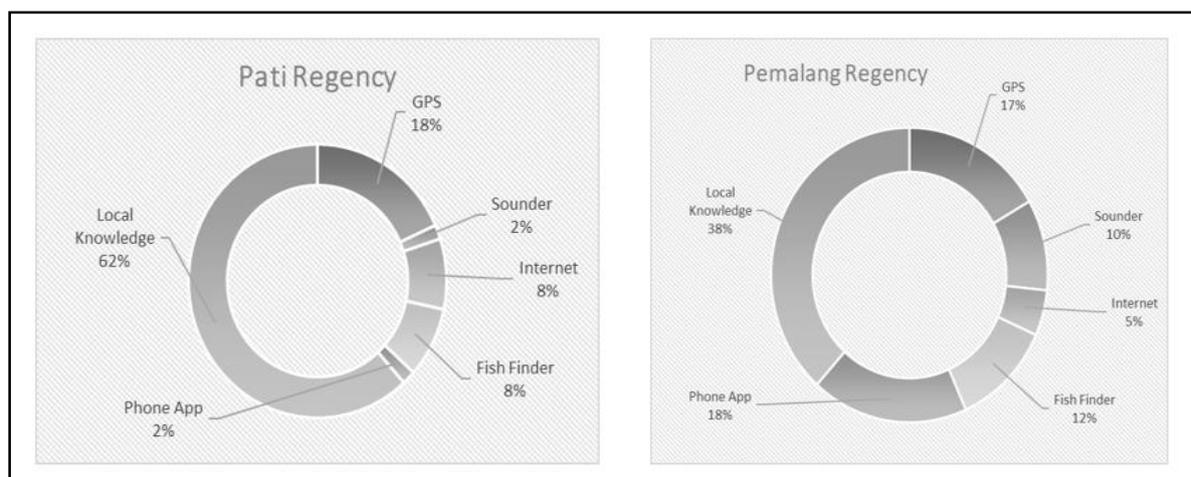


Figure 3. Information and communication technologies used by fishermen when sailing.

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 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.

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.

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.

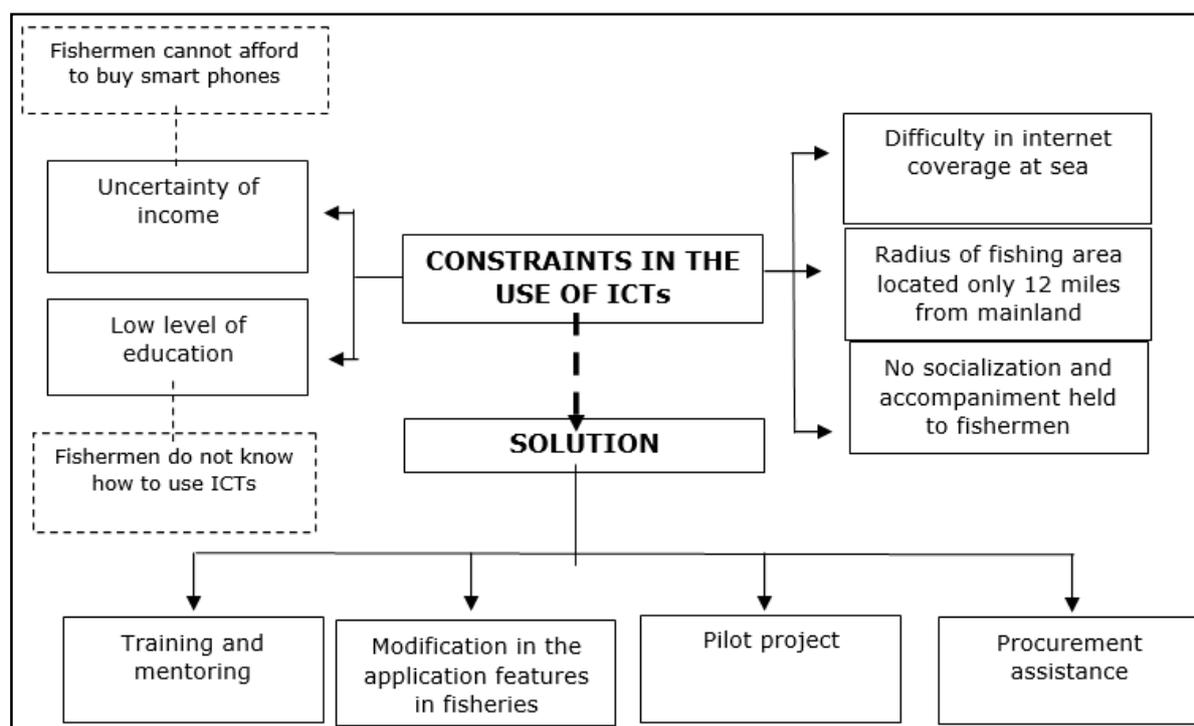


Figure 4. Optimization in the use of information and communication technologies (ICT) in fisheries.

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 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 fishermen 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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Authors:

Sumarjianto Benedictus Maria Nugroho, Faculty of Economics and Business, Diponegoro University, Jl. Prof.

Sudarto, UNDIP Tembalang Campus, 50275 Semarang, Indonesia, e-mail: nugroho.sbm@gmail.com

Indah Susilowati, Faculty of Economics and Business, Diponegoro University, Jl. Prof. Sudarto, UNDIP

Tembalang Campus, 50275 Semarang, Indonesia, e-mail: prof.indah@gmail.com

Mudjahirin Thohir, Faculty of Humanities, Diponegoro University, Jl. Prof. Sudarto, UNDIP Tembalang Campus,

50275 Semarang, Indonesia, e-mail: mudjahirinthohir@ymail.com

Made Ika Prastyadewi, Faculty of Economics and Business, Mahasaraswati Denpasar University, Jl. Kamboja

11A, 80233 Denpasar, Indonesia, e-mail: ika.prastyadewi@unmas.ac.id

Ika Suciati, Faculty of Economics and Business, Diponegoro University, Jl. Prof. Sudarto, UNDIP Tembalang

Campus, 50275 Semarang, Indonesia, e-mail: ikasuci741@gmail.com

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