



Impact of COVID-19 on aquaculture sector in Malaysia: Findings from the first national survey

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ABSTRACT

Malaysian aquaculture sector consists of 391,000 t of cultivated organisms produced per year with an economic value for over USD 700 million as estimated in 2019. The COVID-19 pandemic caused a large global human pandemic and it is currently ongoing, affecting profoundly Malaysian aquaculture, which is vital for seafood provision and security assurance. Thus, to increase our understanding about how the pandemic affects aquaculture sectors is crucial to design possible management measures both at local and national level. To do it, we designed a survey, starting in May 2020, consisting of 25 online questions to collect information about the impact of COVID-19 on the aquaculture sectors in Malaysia. A total of 105 respondents (2625 answered questions) was captured within the Movement Control Order (MCO) period and later extended to the Conditional MCO (CMCO). Almost 90 % of respondents was unanimous in answering that, and COVID-19 had a heavy effect on aquaculture-related activities in Malaysia; 80 % of them indicated the market demand and logistic bottlenecks (72 %) as major constraints on their aquaculture activities. While the major option to solve aquaculture COVID-19 related issues was the use of online market or digital platforms (76 %), a large fraction of respondents requested for specific assistance to support aquaculture activities (e.g. financial support). Most respondents (93 %) was aware about the necessity of the Standard Operation Procedure (SOP) provided by the relevant agencies during the MCO / CMCO. Present data are crucial to develop policy measures both at national and international level to support seafood sectors under pandemic.

1. Introduction

Malaysian Fisheries Sector which includes aquaculture, capture fisheries and inland fisheries have produced 1.85 mt production with the value estimated at USD 3.3 billion (RM 14.5 billion; [Department of Fisheries, Malaysia \(DOF\), 2020](#)). A recent analysis provided by the Department of Fisheries Malaysia (DOF, Malaysia), showed that the Malaysian Gross Domestic Product (GDP) for Agriculture is currently around 12.5 % with the trade value estimated at USD 1.75 billion (RM 7.5 billion; [Department of Fisheries, Malaysia \(DOF\), 2020](#)). Agriculture

sectors contribute for about 92 % of Malaysian Self Sufficient Level and involve over 18,000 farmers in Malaysia. Among them, Malaysian aquaculture sector produces 391,000 mt with an estimated value of about USD 724 (RM 3.1 billion).

A novel coronavirus SARS-CoV-2, now officially known as COVID-19 infected over 6 million people in the world as of 2nd June 2020 and also caused large social and economic repercussions ([World Health Organization - WHO, 2020](#), [Wu et al., 2020](#)). Since the initial outbreak, in December 2019, COVID-19 has spread throughout China and through more than 214 other countries and territories worldwide with only three

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countries declaring zero cases (as recorded at end of May 2020). The pandemic caused global measures taken by several countries such as the Movement Control Order (MCO), travel bans and several business closures to contain the infection. Starting from March 18, 2020, Malaysian government announced the implementation of the MCO with the aim to prevent the COVID-19 spread. Since then, five phases of MCO were implemented and expected to be ended on 9th of June 2020 (as mentioned at the early June 2020). The 'new norm' and 'new normal' - as some are calling it - affected the agriculture activities in many Asian countries (Hossain, 2020).

Among agriculture food sectors, aquaculture also underwent COVID-19 generated effects through direct or indirect impacts and still to date it is experimenting various issues related to the food security and the integrity of the food chain (FAO, 2020a). Rapid dissemination and further assessment of the impact of COVID-19 on aquaculture is needed in order to improve the healthcare system and the environmental security (Edinur and Abdullah, 2020; FAO, 2020b), above all in those areas that heavily rely on aquaculture to sustain local communities such as Malaysia and South East Asian countries.

Thus, seen the importance of aquaculture sectors in many states of Malaysia, the collection of socio-ecological data plays a crucial role to explore possible measures to mitigate the impacts of COVID-19 global pandemic on the aquaculture activities and to reduce the vulnerability of the related livelihoods of communities in the country. Online or Web surveys using various hosted platforms have emerged rapidly in a period of social distancing (Azra, 2020) because of the convenience as a research tool making them vital to build a robust evidence-based scientific information (Gilbert et al., 2011). Therefore, some remote methods based on the circulation of electronic surveys such as those based on Google forms may be effective in collecting real-time data describing the status of a productive sector undergoing critical conditions due to the pandemic. Thus, researchers can be able to create and deliver surveys to related respondents in a convenient, efficiently and expeditious manner in synchronous time, so researchers can watch data results being compiled instantaneously. Another benefit of online surveys is the automatic coding of close-ended questions by the computer, leaving only open-ended questions to be manually code (Selm and Jankowski, 2006).

Here, we used such a remote (online)-based method to increase our knowledge about the COVID-19 effects on aquaculture sectors in Malaysia through a study committed by the Higher Institution Centre of Excellence (HiCoE), Institute of Tropical Aquaculture and Fisheries, Universiti Malaysia Terengganu, Malaysia. Some questions formulated for this study were addressed to farmers and aquaculture entrepreneurs involved directly or indirectly during and after the implementation of the MCO. The main objective of this study was to determine the impact of COVID-19 situation on aquaculture related activities and to propose suitable approach for policy formulation related to this industry in Malaysia.

2. Materials and methods

2.1. Study area

Malaysia is located in the central part of south-east Asia and consists of two land masses, Peninsular Malaysia and East Malaysia. The East Malaysia consists of two states i.e. Sabah and Sarawak, meanwhile Peninsular Malaysia includes others 11 states, and was divided into three different regions, East Coast (Terengganu, Kelantan and Pahang), West Coast (Perak, Selangor, Negeri Sembilan, Melaka and Johor) and Northern regions (Kedah, Perlis, Pulau Pinang) with one Federal Territories which includes Putrajaya, Labuan and Kuala Lumpur.

2.2. Survey

Data were collected through a questionnaire, which was designed to

be fitted online or through the web. The software used was a Google add-on (Google Form) and was distributed online from May 2020 until the end of the MCO period (later known as CMCO period). The questionnaire was circulated in both English and Malay and distributed using two different sampling methods: the Exponential non-discriminative Snowball Sampling and the Respondent Driven Sampling (Kaliszewski et al., 2020; Mchunu et al., 2018; Love et al., 2015; Medlin et al., 1999). Social media platforms (Facebook and WhatsApp) were used to share the survey link. Respondent Driven Sampling method was carried out through consulting and selecting an existing sample (listed by the institute by previous online forum¹), and communicating that the questionnaire was available through a web link. Additionally, the sampling error could not be estimated and controlled seen that the underlying assumption behind, such a calculation usually requires knowledge about the probabilities of selection (Selm and Jankowski, 2006). This survey included quantitative and qualitative data with detailed narrative and numeric outcomes, which met ethical and methodological principles of human research ethics committees by Buchanan and Hvizdak (2009).

2.3. Data collection and analysis

Questions were designed to rapidly assess the perceptions of Malaysian farmers, i.e. people involved in aquaculture related activities associated with the COVID-19 situation and lockdown period. Online Google forms were structured into five sections which included Section A (question 2–5), Section B (question 6–9), Section C (question 10–16), Section D (questions 17–23) and Section E (24–26). Section A aimed to collect personal information about the respondent (gender, age & education level). Section B was about the background of the aquaculture activities of the respondent (state, involvement time, number of employees & type of the aquaculture activities). Questions of Section C dealt with the major issues and challenges of COVID-19 on the respondent's aquaculture activities such as sales, demands, transportation, bureaucracy and employee related problems. The Section D suggested some problem-solving option to cope with some issues and challenges such as sales services, financial assistance, technical services, or restructuring aquaculture business and the final section; finally, Section E assessed the COVID-19 related knowledge of the respondent (SOP, social distancing and personal hygiene).

All of these questions were set to compulsory option, except for the respondent contact email and telephone number, which is optional. The survey used to collect the data is available at Harvard Dataverse²; the survey contains 25 questions, is entirely anonymous and implemented based on the flowchart (Fig. 1) for the respondent to follows.

To prevent multiple responses in this form of online survey from a single person at the maximum level, the setting option to show the link to submit another response in the google form was disabled and the response within five (5) minutes interval times were also excluded from the main dataset. Respondents also could not see the summary charts and text responses to limit possible speculations within the results by the others respondent. Due to the strong social restrictions imposed by COVID-19 pandemic, this study had some limitations that however, as we will show in the results, will not impair the value of collected data. For example, participants could experiment internet access restrictions and could not have specific experience to take the survey at the time it was published. Thus, the sample of respondents was likely to be not at all representative of the general farmers in Malaysia. Another possible source of bias derived from the fact that we were not able to estimate the return rate (RR) value. Actually, we were not able to control the number

¹ Forum on Aquaculture Services (FORAS) website: <https://www.umt.edu.my/index.php?go=highlight&id=468>

² Google Forms Digital Printed File available at <https://doi.org/10.7910/DVN/4EJRXU>

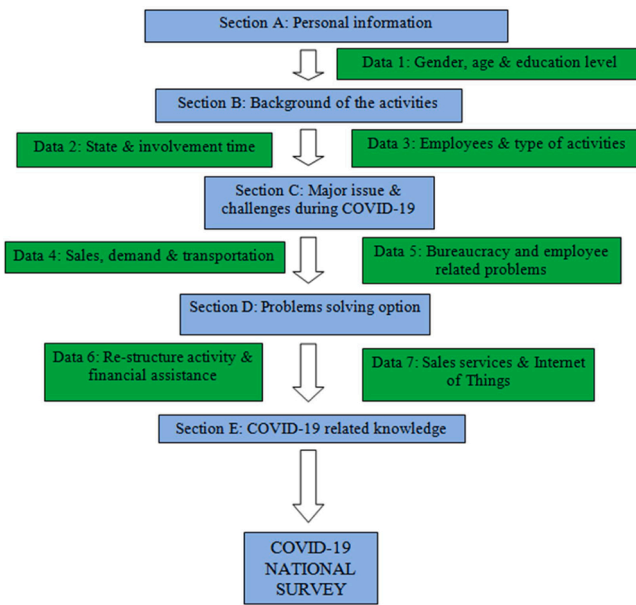


Fig. 1. Flowchart of the online questionnaire for COVID-19 national survey.

of respondents, which might have seen the online forms or its google links but declined to participate. Data from the online survey were exported and analyzed in Excel (Microsoft) and IBM SPSS 24 edition (IBM Corp).

3. Results

3.1. Demographics

A total of 105 responses was captured within the MCO / CMCO and all of the main regions within Peninsular Malaysia, East Coast, West Coast, Northern regions and one Federal Territories as well as the East Malaysia, Sabah and Sarawak had a representative to complete the survey, except from one state, Perlis, from the Northern region in which the survey never captured any response. The highest percentage comes from the East Coast region (39 %), followed by West Coast (33 %), Northern regions (11 %), East Malaysia (15 %) and Federal Territories (2%) (Fig. 2). Less than 5 responses come from Federal Territories, Melaka, Negeri Sembilan and Pulau Pinang. The results on the demographic status showed that most respondents was from the East and West coast regions. This may depend on the current distribution of farms in Malaysia, which are more frequent in these two regions (Department of Fisheries, Malaysia (DOF), 2020).

Respondents were mostly male by percentage (93 %) (Fig. 3A), with

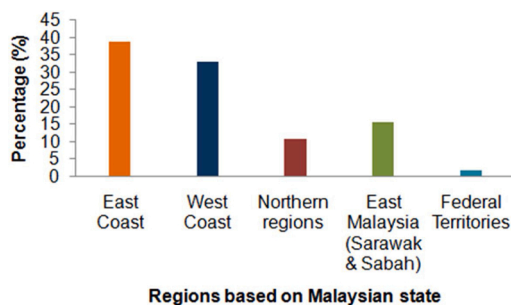


Fig. 2. Percentage of respondents by regions of Peninsular Malaysia and East Malaysia for the study on the impact of COVID-19 on aquaculture industry in Malaysia (East Coast: Terengganu, Kelantan and Pahang; West Coast: Perak, Selangor, Negeri Sembilan, Melaka and Johor; Northern regions: Kedah, Perlis, Pulau Pinang; Federal Territories: Putrajaya, Labuan and Kuala Lumpur).

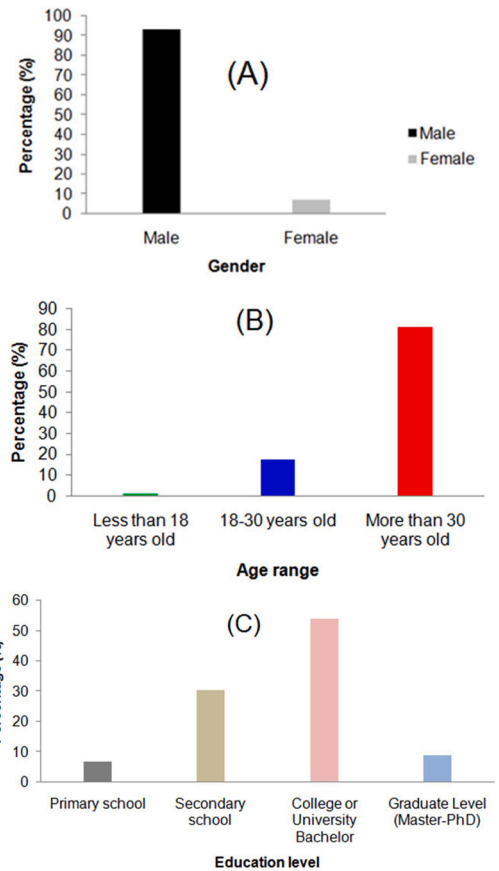


Fig. 3. Percentage of respondent of personal information; (A) Gender distribution, (B) age range and (C) education level for the study on the impact of COVID-19 on aquaculture industry in Malaysia.

a dominant age which was more than 30 years old (81 %), followed by 18–30 years old (17.6 %) and then less than 18 years old (1.4 %) (Fig. 3B). Most survey respondents (93 %) had completed secondary education, with surprisingly almost 63 % having completed education above the College or University Bachelor until the graduate level (Master and PhD) (Fig. 3C). This could depend on the fact that the survey was distributed through the WhatsApp and Facebook and then higher educated people were facilitated to use these electronics means.

3.2. Background of the aquaculture entrepreneurs and activities

3.2.1. Number of employees and involvement time

Number of employees and the involvement time have been considered one among the main factors in determining the respondents' background. Table 1 shows the percentage of respondents based on the number of full-time employees and the type of business based on the size of operation with the total amount of sale turnover. Such a data revealed that most respondents was from small and micro-based business (86 %), while medium to medium-large based business were less common among respondents (~14 %). In Table 2, we summarized data of involvement time of respondents, which may be a proxy to express the experience of farmers. Specifically, most farmers were involved for more than 9 years in aquaculture activities (39 %), while 28 % had an experience between 3 and 9 years and 33 % only 1–3 years.

3.2.2. Type of activities

The question about the type of aquaculture activities was a multiple tick question and this explains why the sum of the percentage was higher than 100 % (Fig. 4A). The most common aquaculture activity was the grow-out culture (62 %, 63 respondents), followed by nursery culture,

Table 1

Percentage of respondents based on the number of full-time employees and type of business based on the size of operation with total amount of sales turnover of the study on the impact of COVID-19 on aquaculture industry in Malaysia.

Number of employee (full-time employees)	Percentage (%)	Type of business based on the size of operation (Sales turnover)
1–5	65.7	Micro business – USD 70,000 (<MYR 300,000)
5–30	20.6	Small business – USD 70,000 to < USD 700,000 (MYR 300,000 to < MYR 3 million)
30–75	6.9	Medium business – USD 700,000 to < USD 4.7 million (MYR 3 million to < MYR 20 million)
75–200	2.9	Medium business – USD 3.5 million to < USD 11.6 million (MYR 15 million to < MYR 50 million)
>200	3.9	Large business – USD 11.6 million (>MYR 50 million)

Table 2

Percentage of respondents based on their involvement time of the study on the impact of COVID-19 on aquaculture industry in Malaysia.

Involvement time	Number of respondent	Percentage of respondent (%)
1–3 years	35	33
3–9 years	29	28
More than 9 years	41	39

especially the seed production (40 %, 41 respondents), ornamental fish activities (25 %, 25 respondents) and broodstock development (19 %, 19 respondents). The less common activities were pond culture for fishing activities with 6%. Fig. 4B shows that the most affected activities during the COVID-19 pandemic and MCO in Malaysian aquaculture industry, and Fig. 4C we report the percentage of respondents involved in the culture of higher value species. The results showed that 72 % of the respondents mostly cultured high value animals (i.e. carnivorous organisms) with higher price per kg.

3.3. Major issues and challenges during COVID-19

Generally, most respondents agreed that the COVID-19 had a profound impact on their aquaculture activities (Fig. 5A). Production (Fig. 5B), market demands (Fig. 5C) and logistics bottlenecks (Fig. 5D), bureaucracy related problems (Fig. 5E), employee related problems (Fig. 5F) and temporary closure of fish mill (Fig. 5G) were indicated as main factors of concern (see below for details).

3.3.1. Production

Most respondent agreed that the main factor affecting their production was the sale decrease (56 %), followed by decrease in price of cultured animals due to oversupply (21 %), stock pile-ups which was driven by low demand (17 %) and increase in sales (7%) (Fig. 5B).

3.3.2. Demands and logistics bottlenecks

Product demands was another factor that respondents considered crucial under present COVID-19 pandemic. Indeed, most respondents agreed that they were affected by the low demand of cultured animals during the MCO (79 %; Fig. 5C), while logistic bottlenecks accounted for about 72 % of respondents mainly due to the transportation related-issues within the MCO period (Fig. 5D).

3.3.3. Bureaucracy and employee related problems

Also bureaucracy was felt as an effective issue. Indeed, most respondents reported an increasing number of potential bureaucracy issues occurred during the MCO periods (38 %); 35 % of respondents said that bureaucracy issues could be solved online while 26.5 % of them stated that there was not involvement with any related government agencies (Fig. 5E). Employee related problems were felt instead as a not effective issue for most respondents (~70 %) seen that they did not have problems with employees trapped in the area of Enhanced Movement Control Order (EMCO) (Fig. 5G).

3.3.4. Temporary closure of fish mill

Fish mill manufacturing activities were not allowed to operate during the MCO. Fig. 5F shows that more than a half of the respondents

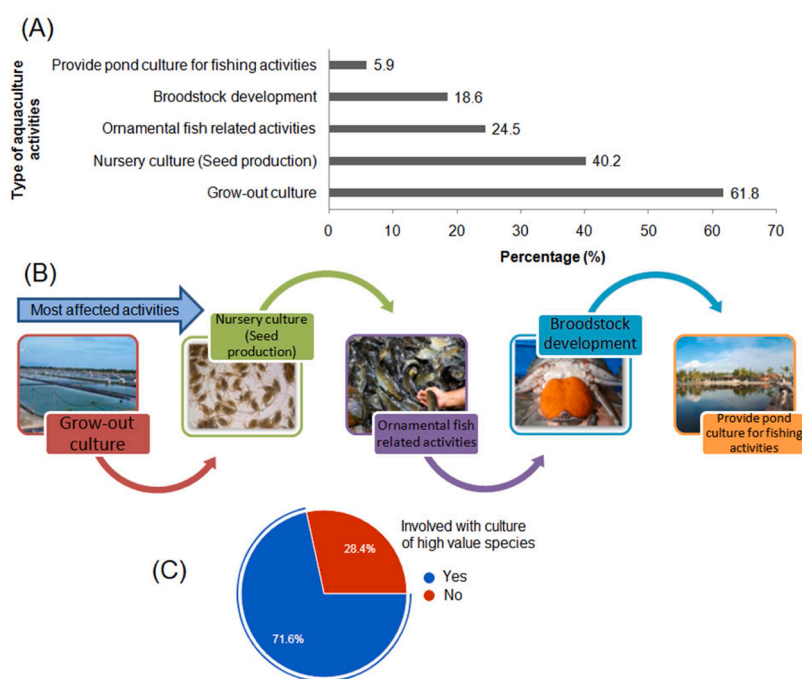


Fig. 4. (A) Percentage of type of aquaculture activities being carried out by respondents; (B) Most affected activities during the COVID-19 pandemic and (C) Percentage of respondents involved with culture of high value species (price per kg more than RM 20) of the study on the impact of COVID-19 on aquaculture industry in Malaysia.

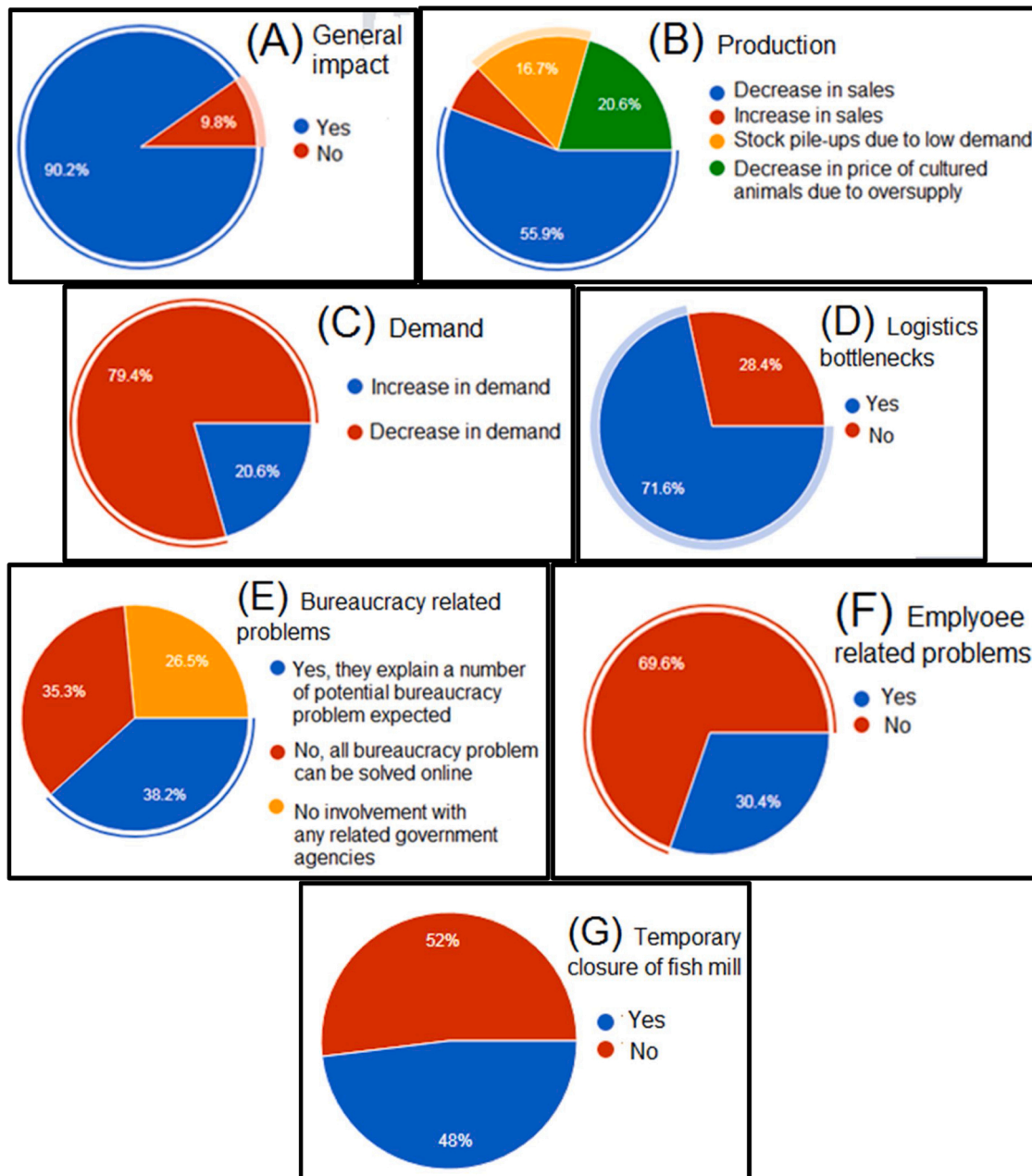


Fig. 5. (A) Percentage of respondent agreed with the general impact of COVID-19 on their aquaculture activities; (B) Challenges faced by the respondent on their aquaculture production; (C) Percentage of respondent agreed that they are affected by the low demand of cultured animals during the MCO; (D) Percentage of respondent having logistics bottlenecks; (E) Bureaucracy related problems; (F) Employee related problems and (G) Temporary closure of fish mill of the study on the impact of COVID-19 on aquaculture industry in Malaysia.

were not affected by the temporary closure of these factories (52 %).

3.4. Problems solving options

3.4.1. Reduce number of employee

Surprisingly, more than a half of the respondents (51 %) did not have issues due to their current number of employees and they did not predict to restructure their current employee number (Fig. 6). However, there were about 31 % of respondents who stated that the reduction of employee number may be among the possible future options to cope with the demand reduction (Fig. 6).

3.4.2. Decrease aquaculture production

Fig. 7 shows that more than a half of the respondents (52 %) will

likely to reduce their culture volume fur to the lower demand and expectedly, around 68 % respondents did not consider to plan a species switching as a possible option.

3.4.3. Go digital

Increasing of the use of digital platforms and/or online market was an effective solution for most respondents (76 %) (Fig. 8). Another large fraction of respondents (88 %) asked for a specific assistance and specifically financial assistance was as one of their most selected options (68 %), followed by sales services (55 %) and technical services assistance (35 %) (Fig. 9A-B; multiple tick question).

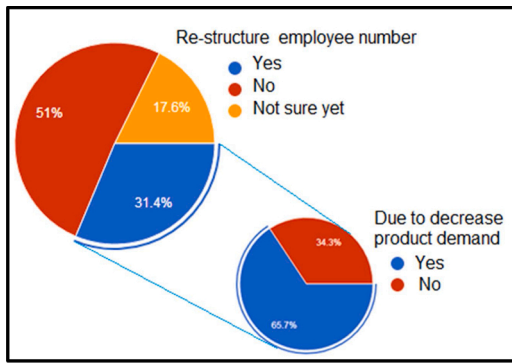


Fig. 6. Percentage of respondent to restructure their employee number (Bigger pie chart) with few of percentage agreed due to the decrease of product demand (smaller pie chart) of the study on the impact of COVID-19 on aquaculture industry in Malaysia.

3.5. COVID-19 related knowledge onto respondent's aquaculture activities

Fig. 10 (A to C) showed the COVID-19 related knowledge of the respondents. In terms of effectiveness of social distancing in aquaculture activities, most respondents agreed that social distancing could be carried out effectively during the operation of aquaculture activities (~60%) (Fig. 10A). The question of whether employees could always maintain good personal hygiene (e.g. through the use of hand sanitizers and face masks), 77% of respondents was confident that these methods did not affect the worker's operation during aquaculture activities. Fig. 10C shows that 93% of respondents was aware of the Standard Operation Procedure (SOP) provided by the relevant agencies during the MCO.

4. Discussion

In response to increasing number of publications to the COVID-19 related study, this study seeks to discover the potential impact of COVID-19 on Malaysian-based aquaculture activities. Apart from other studies recently published arguing on the possible COVID-19 coping strategies in Malaysia (Waiho et al., 2020), present dataset is the first experimental-based study to explore the COVID-19 impact on Malaysian aquaculture industry. Our results showed that most respondents (~90%) expected a negative impact on their aquaculture business and activities and this appeared to be in line with what emerged by other surveys recently carried out in other countries. For example, Senten et al. (2020) in USA also found that over 90% of respondents indicated that their farms or business were impacted by the COVID-19 pandemic. Another important aspect emerged by the present study was that Malaysian farmers are worried about the future as they glimpse large chances to incur in risks that need to be managed in the coming months.

Such a result is relevant from a decision making point of view and it may be a first step to inform the policy making process although our study could have some limitations. For example, our dataset could not be a full representation of the whole aquaculture industry in Malaysia. Nevertheless, we are confident that the present dataset was relevant to test the impact of COVID-19 on Malaysian aquaculture sector since data collection was carried out only during the MCO/CMCO period. Another factor that could decrease the reliability of the sampling effort was that many Malaysian farmers are not familiar with internet-based

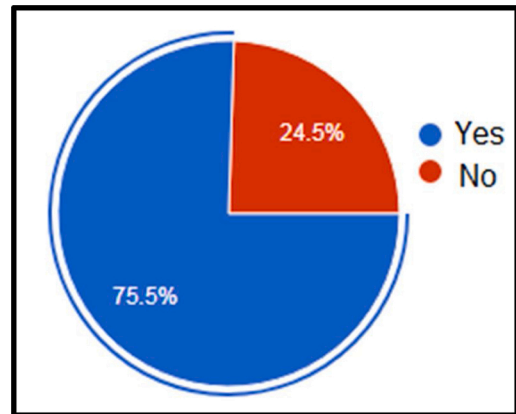


Fig. 8. Percentage of respondents attempts to solve their aquaculture problems using digital platform or online market for the study on the impact of COVID-19 on aquaculture industry in Malaysia.

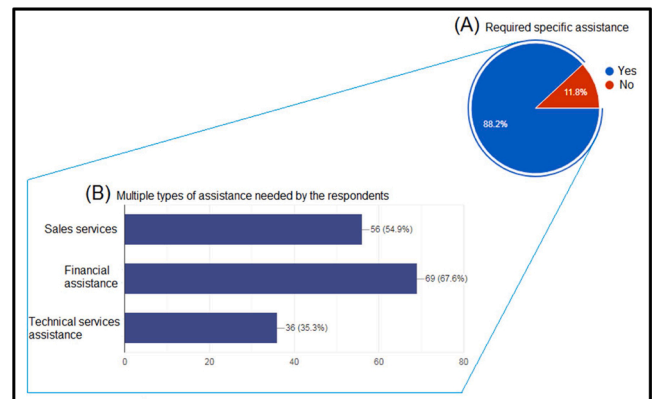


Fig. 9. (A) Percentage of respondents who required specific assistance for their affected aquaculture activities and (B) Types of multiple assistance needed by the respondents in percentage of the study on the impact of COVID-19 on aquaculture industry in Malaysia.

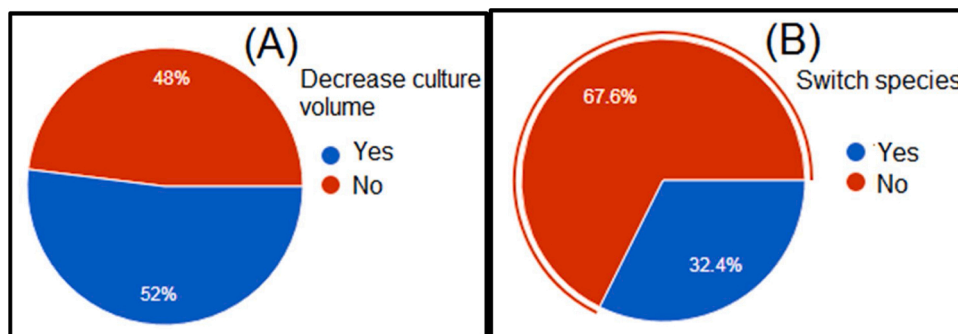


Fig. 7. (A) Percentage of the respondents which likely to reduce their culture volume and (B) Percentage of respondents which likely to switch to other species to sell after MCO for the study on the impact of COVID-19 on aquaculture industry in Malaysia.

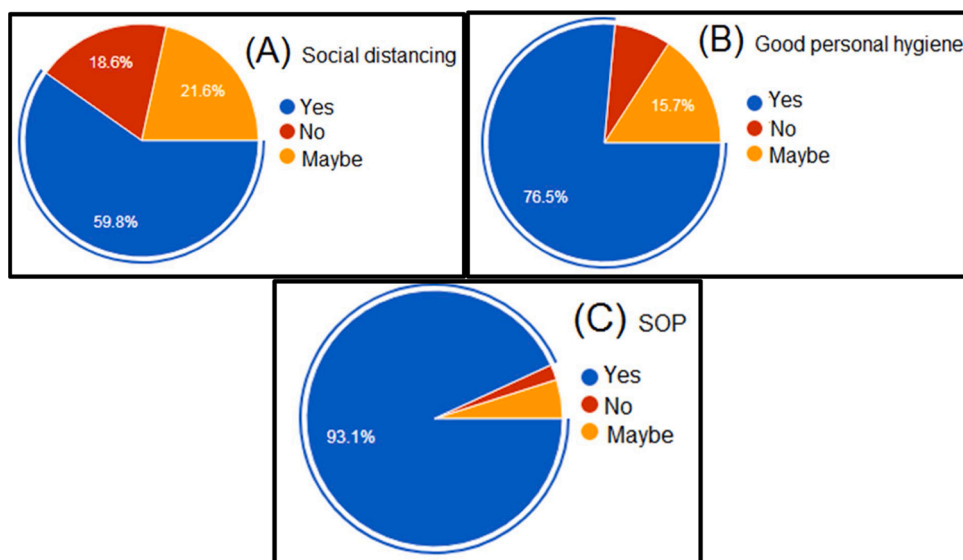


Fig. 10. (A) Percentage of effectiveness of social distancing in aquaculture activities, (B) Percentage of employees maintaining good personal hygiene, such as use of hand sanitizer and face mask during the aquaculture activities and (C) Awareness of respondents of Standard Operation Procedure (SOP) provided by the relevant agencies during the MCO for the study on the impact of COVID-19 on aquaculture industry in Malaysia.

technologies and in some areas of the country internet connection is not stable. Nevertheless, we were forced to distribute the survey through the web-based connection due to the pandemic and then we expect that a certain - not estimable - fraction of potential respondents was not considered in the present sample size due to connection limitations. Nonetheless, we are confident that the resulting sample size was enough to record the effect of COVID-19 pandemic on aquaculture in our study areas.

4.1. Demographic status

Our survey was based on a total of 2625 answers which were provided throughout the study period entirely falling into MCO and CMCO periods. Our survey showed that the most percentage of farmers was from both East Coast and West Coast regions, and specifically from those regions Terengganu and Perak where there is the highest occurrence of farms (Department of Fisheries, Malaysia (DOF), 2020). In fact, such regions host most marine aquaculture farms in Malaysia likely thanks to the larger coastal areas, which are highly suitable for aquaculture. Over two-thirds of respondents declared to have educational higher degrees showing that aquaculture might be attractive also for these categories of people. The mean age percentage was about 30-y old (81 %) and this could be explained by the fact that aquaculture activities require large investment and costs of operation to be able to fully operate until the production process (Shang, 1985). On the other hand, aquaculture needs a certain amount of initial capitals in order to gather juveniles and feed and to purchase lands and space where to carry out facilities. This may represent one among the major constraint to start new aquaculture farms (Brummett et al., 2004). Thus, our results dealing with the age of respondents (over 30) could be explained by the fact that most of them should reach a sufficient ability to save enough capital or make a loan for starting the aquaculture-based business and to create a winning enterprise may need a higher educational degree.

4.2. Aquaculture entrepreneurs and activities

We showed that most respondents were from the small and micro-based business with sales turnover less than USD 70,000 (MYR 300,000). These companies had a small number of full time employees, usually less than 30 workers which were highly experienced about aquaculture activities. This type of data (business and experience) might

assist policy makers to increase their understanding about towards where to address mitigation measures to cope with COVID-19 effects on Malaysian aquaculture. The most common aquaculture activities recorded by our survey was the grow-out farms that appeared to be the most affected one during the COVID-19 and MCO in Malaysian aquaculture industry. In contrast, pond culture for fishing activities was the least common among respondents and according to the low frequency no special Standard Operating Procedure (SOP) has been still designed for those types of aquaculture activities (up until 1 st June 2020). The number of responses captured from the study also showed that most respondents cultured expensive species (i.e. carnivorous) with price per kg larger than RM 20. According to an early preliminary report by FAO (FAO, 2020b), high-valued commodities seems those more exposed to the COVID-19 impact due to the lack of export from flight closures and huge drop in sales to hotels and restaurants.

4.3. Current issues and challenges during COVID-19

Small and micro-based businesses were directly or indirectly affected during the MCO period. COVID-19 pandemic seems to alter socio-economic norms, especially in aquaculture sectors where are eliciting frantic responses worldwide to increase the likelihood of a quick recovery (Rowan and Galanakis, 2020). Previous study found that COVID-19 global pandemic adversely impacted the Indian shrimp production and supply chain (Kumaran et al., 2021). Our study revealed that major issues and challenges such as production, product demands, bureaucracy related problems, transportation and temporary closure of fish mills were affected by the COVID-19. However, this survey also found that employee-related problems were less common for the respondents. The decrease of sales due to pandemic was the biggest problem for Malaysian aquaculture as recorded through the 56 % respondents. Pandemic seems to affect the supply chain reducing importations and distribution of fish or feed, the supply and distribution of aquaculture products caused by the international and domestic travel and transport restrictions and lockdowns (FAO, 2020b). Previous analysis across 26 countries also showed that most of the business sales decreased significantly during the lockdown or during the MCO periods (Vito and Gomez, 2020). The current MCO in Malaysia results in the restriction of all public operation to only critical/essential services. Domestic aquaculture demand is likely affected by the reduction of tourist industry and restaurants and this was recorded by our study as

showed in Fig. 5. Although the aquaculture is listed as an essential service under the food security sector, working/opening hours and demand from customers were limited by the curfew/confinement (FAO, 2020a). Dao (2020) also reported that domestic demand for luxury seafood dropped and markets collapsed for Vietnamese shrimp and many other aquaculture products. Ocampo (2020) showed that slashed prices due to reduced demand from Philippines's local restaurants and hotels had a severe negative impact on agriculture activities and factories, which operate at reduced capacity. Our study also found that fish mill manufacturing factories were not allowed to operate during the MCO (at least up until the 4th May 2020). The logistic bottlenecks are still being considered as one among the most important challenges faced by most respondents (>70 %). However, a larger percentage of logistic bottlenecks as, for example those due to transportation restrictions, might be related to the movement of fish seed (Ghosal, 2020) and caused by the shipment restriction to the fish market, which was being closed during the MCO period. Additionally, this could be also related to the international import / export aquaculture business with a reduced effect on national aquaculture trade. There are still not studies in terms of bureaucracy related problems on the aquaculture activities during the MCO period. However, a recent FAO (2020c) revealed that small and medium enterprises (SMEs) in Mexico, including agricultural enterprises, should minimize their bureaucracy problems and allow immediate access to their newly introduced subsidised credit. About 70 % respondents did not have any problems with employees trapped in the area of EMCO (more than 3000 residents per 350 unit of village/condo units/premises) as employees might not live around the highly populated area because of the aquaculture activities are usually carried out in rural areas.

4.4. Problems solving option

For about 50 % of the respondents the reduction of employee number was the last option to be chosen. While the likelihood to reduce employees is low in small and micro-based business, it is expected in medium and large business with a large number of employees (~200 workers). Unemployment rate could soar in the coming years due to the dire predictions by the international organization (Bennett et al., 2020) caused by the post COVID-19 pandemic and it might affect the aquaculture sector in the next future. This could be confirmed by the fact that a small fraction of respondents, about 30 %, agreed to reduce their number of employees and this might be caused by the reduction in product demand. One among the most probable option among the respondents could be the reduction of culture volume to cope with the decrease in sales. The survey also found that respondents were not planning to switch to other species, which are easier to sell after COVID-19 pandemic. Such an option could be difficult to address as the change cultivation setup to host new species could be not quickly and easily practicable. Thus, decreased aquaculture production by restricted culture of high value species will be the another option during the MCO and post-COVID-19 period. The direct marketing may be difficult due to the social distancing. Indeed, about 76 % of the total respondents, tried to solve their increased aquaculture problems (e.g. oversupply issues) using online marketing. To cope with these issues, most respondents was forced to resort to the financial assistance as one among the most common options instead to resort to other options dealing with sales and technical services. Thus, further economic stimulus packages should/might include special financial assistance for farmers who are affected by the COVID-19 and MCO period.

5. Conclusion and recommendations

COVID-19 mostly affected the aquaculture's demands in Malaysia through a direct effect on the sales. One among the most effective solving-option to mitigate detrimental effects deriving from the decreasing ability to stay on market is resorting to digital platforms.

Nonetheless, even though the government of Malaysia has rolled out some initiatives to help Malaysian people to cope with the lockdown phase, COVID-19 pandemic may affect heavily the aquaculture activities in this country. In coping with COVID-19 emergency, we suggest to conduct programmes to increase the ability to proactively manage new risks caused by the COVID-19 and not only, also those deriving from climate change-related issues (Sarà et al., 2018; Mangano et al., 2019). One among the most important adaptation measure that seems to be adopted in many countries deals with investment in scientific research to prepare most social and economic layers for future pandemics. We suggest that this choice should be a top priority also in Malaysia. Such investments will elicit new scientific national and international collaborations between scientific research both public (e.g. academy) and private and aquaculture to improve our ability to cope with the impact of COVID-19.

CRediT authorship contribution statement

Mohamad N. Azra: Writing - original draft, Validation. **Nor Azman Kasan:** Writing - review & editing, Validation. **Rohisyamuddin Othman:** Data curation, Investigation, Validation. **Gusti Afiz Gusti Ruslan Noor:** Data curation, Investigation, Validation. **Suhairi Mazelan:** Data curation, Investigation. **Zainoddin Bin Jamari:** Methodology, Validation. **Gianluca Sarà:** Conceptualization, Validation. **Mhd Ikhwanuddin:** Conceptualization, Validation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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