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COVER LETTER

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27 Maret 2023

Dear,
We wish to submit an original research article entitled “Resonance analysis of fan blade design using Finite Element Method” for consideration by SINERGI.

We confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere.

In this paper, we report on / show that:

Topic	:	Resonance analysis of fan blade design using Finite Element Method
Brief Background	:	The fan is also a system with mass and elasticity that can experience vibrations when subjected to disturbances [1], [2]. The disturbance can come from the system itself (free vibration), or it can also be caused by external influences (forced vibration). Due to the large and elastic properties of the material, as well as the disturbance or excitability, the fan-like machine structure is a vibration system [3], [4]. Vibration frequency is the number of vibrations made by the system in one second or the number of vibration periods at one time [5]. A state of resonance occurs when the frequency of the excitation force coincides with one of the natural frequencies of the system. Increasing the individual frequency of the system creates very significant vibrations. In a system subject to vibration, the determination of the individual frequencies is of utmost importance. From rotating machine modules, motion analysis software using the finite element approach can build and simulate unbalanced models. Up-down models and graphs can be created using Solidworks application [6]–[8]. For example, a model of a spinning machine and a graph showing its acceleration with time. By using the finite element method, a module of a rotating machine can be simulated, resulting in several modes. At 1280 rpm, the rotary engine module deviation is projected into five different modes. The operating frequency of the rotary

machine module must be different from the individual frequency anticipated using finite elements. The 1280 rpm figure is still above the individual frequency and will not cause mutually reinforcing vibrations so as to make the module construction safe [9]–[11].

Resonance is a phenomenon that occurs when an oscillating system is affected by a series of periodic pulses that are the same or nearly the same as one of the natural frequencies of the system's oscillations. The system will oscillate with a relatively large amplitude or maximum amplitude [12], [13]. Resonance must sometimes be suppressed in everyday life, otherwise it can lead to danger or disaster. Similar to the incident described above, another collapse of the Tacoma Strait suspension bridge occurred in the United States in 1940. The wind blowing through the bridge at a certain speed and frequency also creates resonance in the bridge. The bridge began to sway aggressively, eventually leading to its collapse [14]–[16].

Using the finite element method, it is possible to translate fan vibrations using rigorous mathematical calculations. The finite element approach is a computer-based procedure for analyzing continuous structures and materials. This strategy is based on the concept of building complex objects with a small number of simple bricks or by reducing complex objects into small manageable pieces [17]–[19]. The finite element method itself uses a numerical method to solve the boundary value problem which is characterized by partial differential equations and boundary conditions. Vibration analysis is a method that has been effectively used to detect the initial damage that occurs to a machine, especially for the purpose of detecting the location of the damage that has occurred [20], [21].

In this study, the authors would like to add references related to resonance in structural vibration [22]. The mitigation strategies employed to minimize structural vibration can be categorized into three main approaches: vibration source damping, propagation damping, and structural vibration reduction [23], [24]. Some researchers proposed a set of recommendations aimed at mitigating floor vibration issues caused by external disturbances, drawing from their analysis of various case studies encompassing office buildings, resonance. In order to mitigate vibration in power equipment, the motor's speed can be decreased using either a frequency converter or a gearbox. This ensures that the operating frequency of the motor does not coincide with the natural frequency of the structure, so avoiding resonance [25]. In the context of a coal conveying tower project, it was observed that significant vibrations were present within the tower during

		motor operation. This phenomenon can be attributed to the near proximity of the vertical vibration frequencies shown by both the motor and the floor, leading to a state of resonance. Following the adjustment of the motor frequency, it was observed that the vibration phenomenon exhibited a significant reduction. One approach to mitigating transmission path vibration involves implementing vibration isolation ditches or piles between the structure and the external source of vibration. This serves to impede the propagation of waves generated by the vibration source towards the building [26]–[28]. Measures aimed at reducing structural vibrations encompass various strategies. These strategies may involve enhancing the foundation's stiffness or implementing floating slabs to mitigate the transmission of vibrations to the structure's interior. Additionally, the installation of steel braces between columns or the incorporation of shear walls can be employed to reinforce the lateral stiffness of industrial factory buildings [29]. In this study, variations in the angle and number of fan blades for natural frequencies will be studied using the finite element method using Solidworks to identify the magnitude of the effect on the modifications made and to prevent resonance with the motor rotation.
Research Problem	:	Increasing the natural frequency of the system creates incredibly significant vibrations. Therefore avoiding vibration resonance in a design, the determination of the natural frequencies is of utmost importance. The author finds several studies that do not address the problem of resonance when designing a machine and other objects. Even though resonance can cause big losses and even lives at stake. Moreover, to the best knowledge of the authors, no one has discussed the effect of the specific number and angle of the fan blades on resonance.
Overview of Method	:	The process of designing fan blades starts with creating a 3D model of fan blades using Solidworks with several models of varying blade angles and the number of fan blades. This process must be done carefully so that when the analysis does not occur errors. Simulating an image of a fan blade and analyzing its natural frequency with the finite element analysis (FEA) method on solidworks until the data results are released. This FEA analysis was carried out numerically with the aim of getting the desired results with variations in the angle of the blades and the number of blades. If the FEA simulation and analysis is running, then it can proceed to the next process. However, if there is a failure in the simulation and FEA analysis process on Solidworks,

		then it returns to the process of changing the geometry of the 3D model until finally the frequency analysis is successfully carried out. Each design variation will be compared with its frequency value. Selection of the best design in terms of the difference in the value of the frequency of the fan blades with the motor. The analysis process goes through several stages that must be carried out, namely, setting the analysis parameters, the process of creating a mesh, the process of running the analysis, and the results of the analysis. The last step is to analyze the natural frequency result data obtained from solidworks to get the desired results.
Significant finding	:	1. A spacific CAD modelling 2. The process of finding the optimal design and resonant frequency before the actual design using CAD. 3. The relationship between the number and angle of blades to natural frequency.

We have no conflicts of interest to disclose.

Thank you for your consideration of this manuscript.

Sincerely,

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AUTHORSHIP STATEMENT

We wish to submit an original research article entitled "*Resonance analysis of fan blade design using Finite Element Method*" for consideration by SINERGI.

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript.

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Please submit 3 (three) potential reviewers (*that have not listed in SINERGI*) to speed up the review process that competent for the topic and has a good reputation in that area.

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