

CHANGES IN MUHAMMADIYAH'S FAJR PRAYER TIME CRITERIA: THE STRUGGLE BETWEEN SCIENCE AND RELIGION

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Abstract

This article explains the science-religion struggle regarding the change in Muhammadiyah's dawn prayer time criteria, where this decision appears to be inconsistent with the research results of three previously appointed institutions. This research falls into the qualitative category, utilizing literature reviews related to the changes in Muhammadiyah's Fajr time criteria. The theory of science-religion relations is employed to dissect how the science-religion struggle is manifested in this decision. In practice, other research, philological studies, and the application in other Muslim countries also contribute to the considerations. The science-religion struggle in Muhammadiyah's decision is classified as an integrative typology in Ian Barbour's theory of science-religion relations. However, as an organization, Muhammadiyah is bound by rules to achieve its goals, guided by the Manhaj Tarjih and masalah. Although not explicitly neglecting the scientific aspect, setting -18° as the new criterion for Fajr time indicates Muhammadiyah's inconsistency in applying the research results of its three competent internal institutions.

Keywords: Sadik Dawn, Prayer Times, Science and Religion.

Abstrak

Artikel ini menjelaskan tentang pergumulan sains-agama dalam hal perubahan kriteria waktu subuh Muhammadiyah, dimana ketetapan ini terlibat tidak sesuai dengan hasil penelitian 3 lembaga yang telah ditunjuk sebelumnya. Penelitian ini tergolong pada penelitian kualitatif dengan menggunakan kajian kepustakaan terkait dengan perubahan kriteria waktu subuh Muhammadiyah. Teori relasi sains-agama digunakan untuk membedah bagaimana pergumulan sains-agama dalam keputusan ini. Pada praktiknya, penelitian lain oleh kader Muhammadiyah, kajian Filologi, dan penerapan pada negara muslim lain. Pergulatan sains-agama dalam keputusan Muhammadiyah ini tergolong tipologi integrasi dalam teori relasi sains-agama Ian Barbour, namun sebagai sebuah organisasi Muhammadiyah memiliki keterikatan terhadap aturan dalam pencapaian tujuan, dalam hal ini berpedoman kepada manhaj Tarjih dan kemaslabatan. Walaupun tidak serta merta sebagai pengabaian terhadap aspek sains, namun penetapan angka -18° sebagai kriteria baru waktu subuh menunjukkan ketidakkonsistenan Muhammadiyah dalam menerapkan hasil penelitian 3 lembaga internalnya yang berkompeten.

Kata Kunci: Fajar Sadik, Waktu Shalat, Sains dan Agama.

Background

The discourse on changing the criteria for the initial time of Muhammadiyah's Fajr prayer began to unfold with the publication of Sheikh Mamduh Farhan al-Buhairi's article titled "Salah Kaprah Waktu Subuh", which was featured in Qiblati Magazine. This was followed by the release of a book by Agus

Hasan Bashori and others, titled "Koreksi Awal Waktu Subuh"¹.

The discourse on changing the criteria for the initial time of Fajr prayer became a heated topic

¹ Sriyatin Shodiq, 'Kapita Selekta Fatwa Dan Putusan Tarjih Kriteria Awal Waktu Subuh/Fajar Perubahan Dan Konsekuensinya', *Pengajian Tarjih Edisi 123 Dengan Tema Kriteria Awal Waktu Subuh/ Fajar* (Yogyakarta: Majelis Tarjih dan Tajdid PP Muhammadiyah, 2021).

within Muhammadiyah, leading to the theme "Reevaluate the Initial Time of Fajr" being discussed at the 27th Tarjih National Conference in 2010 at the University of Muhammadiyah Malang. However, the proposal to change the criteria for the initial time of Fajr during this conference was not accepted by the participants, and the criteria remained at -20° . Since the 27th Tarjih National Conference in 2010, Muhammadiyah has conducted an in-depth study on the criteria for Fajr al-Sadiq, including appointing three internal institutions of Muhammadiyah to conduct intensive research/observation on the criteria for the initial time of Fajr/Fajr al-Sadiq: Islamic Science Research Network (ISRN) Universitas Muhammadiyah Prof. Dr. Hamka (UHAMKA) Jakarta, Pusat Studi Astronomi (Pastron) Universitas Ahmad Dahlan (UAD) Yogyakarta, dan Observatorium Ilmu Falak Universitas Muhammadiyah North Sumatera (OIF UMSU)².

The ISRN-UHAMKA study conducted a comprehensive analysis of 750 days of global Fajr data and concluded that Fajr occurs when the Sun is at approximately -13 degrees below the Eastern horizon. For Indonesia, it is known that the Sun's height at the initial time of Fajr ranges between -12.75 and -13.58 degrees (with a margin of error of 3.13%)³. The OIF-UMSU study found that the Sun's height at the initial time of Fajr is -16.28 degrees below the Eastern horizon⁴. Meanwhile, the Pastron-UAD study suggested that the initial time of Fajr does not occur at a Sun height of -20 degrees or -18 degrees below the Eastern horizon but at a smaller degree⁵.

² Majelis Tarjih dan Tajdid PP Muhammadiyah, 'Tanfidz Keputusan Musyawarah Nasional Tarjih Ke-27', *Tanfidz Keputusan Majelis Tarjih Dan Tajdid PP Muhammadiyah* (Yogyakarta: PP Muhammadiyah, 2014).

³ Tono Saksono dkk, *Draf Materi Musyawarah Nasional Tarjih Muhammadiyah XXXI* (Yogyakarta, 2021).

⁴ Arwin Juli Rakhmadi Butar-butur, 'Data SQM Dan Pola Waktu Subuh Di Sumatera Utara', in *Webinar Nasional Mengkaji Ulang Munculnya Fajar Di Indonesia Dan Dunia* (Jakarta: Universitas Muhammadiyah Prof. Dr. Hamka Jakarta, 2020).

⁵ Yudhiakto Pramudya, 'Perkembangan Penelitian Penentuan Awal Waktu Salat Subuh Dengan Menggunakan

The results of the three internal institutions' research appointed by Muhammadiyah indicate that the trend of Fajr emergence occurs at a Sun depth smaller than -18 degrees. Although the data distribution indicating a Sun height of -18 is very small, Muhammadiyah has chosen this criterion for deciding on the 31st Tarjih National Consultation on the Criteria for the Initial Time of Fajr, as mentioned above. Disregarding the results of this research raises doubts about the scientific validity of Muhammadiyah's decision to change the criteria for the initial time of Fajr, which is then used practically in determining the initial prayer times of Muhammadiyah.

Previous studies relevant to the prayer time theme include Ahmad Izzuddin and M. Basthoni's research titled "Using Command-Line and Graphical User Interfaces Program in Determining Dawn in Pollutive and Non-Pollutive Area," which revealed that the ideal location for Fajr research is in an area without light pollution with clear conditions (Category 3 Bortle Scale), and true dawn is first detected when the Sun is about -19.6° . Tasnim Rahman Fitra's study titled "Moderate Islamic Jurisprudence: Study of Muhammadiyah's Decision on Changes in Criteria for Fajr Prayer Time" elaborated on the concept of moderation contained in Muhammadiyah's decision regarding the change in the initial time of Fajr⁷. Subsequent studies include Susiknan Azhari's "Tracing The Concept Of Fajr In The Islam Mosaic And Modern Science," which found two causes for differences in understanding Fajr: the general nature of Imamah Jibril's hadith in thought and different approaches in understanding the hadiths "*ghalas*"

Sky Quality Meter', in *Halaqah Nasional Abli Hisab Muhammadiyah* (Yogyakarta: Majelis Tarjih dan Tajdid PP Muhammadiyah, 2018).

⁶ Ahmad Izzuddin and M. Basthoni, 'Using Command-Line and Graphical User Interfaces Program in Determining Dawn in Pollutive and Non-Pollutive Area', *Webology*, 19.1 (2022), 79–91.

⁷ Tasnim Rahman Fitra and Ade Silvana, 'Moderate Islamic Jurisprudence: Study of Muhammadiyah's Decision on Changes in Criteria for Fajr Prayer Time', *Mazahib*, 20.1 (2021), 43–76 <<https://doi.org/10.21093/mj.v20i1.3150>>.

and "isfar" without considering the conditions and weather at that time⁸. Rusli et al.'s research titled "Determination Dawn of Shadiq in Masalembu Island by Using Image Processing Sobel Edge Detection Technique" showed that the Sun's height at dawn based on image processing is -19.7128 with a standard deviation of 1.114429⁹. Lastly, Sirajuddin et al.'s study titled "Analysis of Factors Affect the Differences of the Determination of Fajr Şādiq and Its Relevance to the Basic Principles of Sharia" recommended setting the Fajr şādiq angle between -18° and precaution 2 minutes or -17.5°¹⁰.

Through an examination of the aforementioned previous studies, it can be concluded that no academically similar research has been found to the study titled "Changes In Muhammadiyah's Fajr Prayer Time Criteria: The Struggle Between Science and Religion".

This research will examine the struggle between science and religion regarding the change in prayer time criteria decided by Muhammadiyah. Therefore, the most suitable type of research is qualitative research. The analysis method considered most appropriate to explain this research is the descriptive-analytic method, which will certainly try to elaborate on matters related to the issues in the research. Meanwhile, data collection is conducted through study of library materials, in-depth interviews, and focus group discussion.

The Theory of the Relationship Between Science and Religion

⁸ Susiknan Azhari, 'Tracing the Concept of Fajr in the Islam Mosaic and Modern Science', *AHKAM*, 18.1 (2018), 219–32.

⁹ Rusli, Niswatul Kariimah, and Mahfudz, 'Analysis of Factors Affect the Differences of the Determination of Fajr Şādiq and Its Relevance to the Basic Principles of Sharia', in *The 4th International Conference on Law, Technology, Spirituality and Society (ICOLESS)*, ed. by Sudirman Hasan (Malang: Fakultas Syariah Universitas Islam Negeri (UIN) Maulana Malik Ibrahim Malang, 2021), pp. 57–66.

¹⁰ Sirajuddin, Azwar, and Aswar, 'Analysis of Factors Affect the Differences of the Determination of Fajr Şādiq and Its Relevance to the Basic Principles of Sharia', *Kawanua International Journal of Multicultural Studies*, 4.1 (2023), 1–15.

The theory of the integration of knowledge is crucial in this study. The specific theory of knowledge integration employed is the one put forth by Ian G. Barbour. He proposes that four typologies emerge when science encounters religion: conflict, independence, dialogue, and integration. The conflict typology arises when science and religion are seen as two distinct and even conflicting paradigms, placing adherents of science and religion in opposing positions. The independence typology views science and religion as separate entities, each functioning autonomously and distinctly. They are divided by the issues studied, references, and methodologies. The Dialogue typology positions science and religion as two entities that can compromise, reasoning that both exist on an equal footing. This typology emphasizes similarities or commonalities over differences, unlike the independence typology. Meanwhile, the integration typology becomes the most relevant theory because it explains that scientific theories resulting from scientific studies can play a significant role in the changes or formulation of religious doctrines. Barbour then states that religion can contribute to science, and conversely, science can contribute to religion, describing simply that there is an interdependence and relationship between religion and science that can influence each other. Barbour refers to this as systematic synthesis¹¹.

Barbour's integration theory is indeed considered highly relevant to this study, as the prayer times are derived through the transformation of the daily position of the Sun into specific prayer timings. Therefore, it cannot be separated from scientific analysis related to the Sun's position. The scientific aspect is crucial in determining prayer times, and neglecting this scientific aspect would result in the inability to identify and establish prayer times¹². Barbour's

¹¹ I G Barbour, *When Science Meets Religion: Enemies, Strangers, or Partners?* (HarperCollins, 2013).

¹² Aaron Rock-Singer, 'Prayer And The Islamic Revival: A Timely Challenge', *International Journal of*

integration theory is then utilized to delve deeply into the extent of the contribution of science in determining the pre-dawn prayer (Fajr) time, which leads to the decision to change the criteria for dawn from the perspective of Muhammadiyah.

The Conception of Prayer Times

Prayer in the Shariah sense has a uniform definition, as found in the books of Islamic jurisprudence (fiqh). Scholars provide a comprehensive and precise definition, stating that it is a worship ritual that involves both utterances and actions. It commences with the *Takebiratul Ibram* (the opening proclamation of "Allahu Akbar") and concludes with the *Salam* (the greeting of peace). There are specific conditions and pillars that have been predetermined for the validity of this worship¹³.

Prayer is a worship ritual with specified timings. This understanding is derived from the interpretations of the verses of the Quran and the sayings of the Prophet (*Hadith*)¹⁴ it is understood that there are five obligatory prayer times. Dhuhr time begins when the sun declines, shortly after reaching its zenith in its daily orbit, until the arrival of the Asr time. As for Asr time, it starts when the shadow length of an object equals its height and adds the shadow length at the time of the sun's culmination, until the arrival of the Maghrib time. Maghrib time begins at sunset until the disappearance of the red twilight or until the arrival of the Isha' time. Isha' time starts after the disappearance of the red twilight until midnight, some also state that the end of Isha' prayer is when dawn breaks. Fajr time begins at the break of dawn until sunrise¹⁵.

The Fajr prayer time, which is the focal point of discussion in this study, begins from the break of dawn until the sun is about to rise. The dawn referred to is the "*Fajr Sadik*," understood in the field of astronomy as the beginning of astronomical twilight¹⁶. This astronomical dawn light starts to appear on the eastern horizon before the sunrise, when the sun is positioned approximately 18° below the horizon or at a zenith distance of 108°. Another opinion suggests that the emergence of Fajr Sadik begins when the sun is at a position of 20° below the horizon or at a zenith distance of 110°¹⁷.

One of the factors influencing prayer times is the geographical position of an area, which is also related to the apparent daily movement of the sun from east to west. Therefore, the further west an area is located, the later its prayer times will be. Consequently, prayer times also have jurisdictional boundaries (*wilayahul hukum*) for each region. In this regard, the Ministry of Religious Affairs of Indonesia determines the jurisdictional boundaries for prayer times at the district/city level, meaning that each district/city has its own schedule for prayer times.

Majelis Tarjih and Tajdid Muhammadiyah and Its Method of Ijtihad

Majelis¹⁸ Tarjih and Tajdid¹⁹ is an auxiliary body formed by Muhammadiyah's leadership to delve into specific issues related to Islamic religion, including matters of Falak (astronomy and sighting). The Tarjih and Tajdid Council was initially established during the 16th congress of Muhammadiyah in 1927 in Pekalongan under the name Majelis Tarjih. In its early stages, the

Middle East Studies, 48.2 (2016), 293–312 <<https://doi.org/DOI: 10.1017/S0020743816000052>>.

¹³ Imam Taqiyuddin, *Kifayatul Akhyar Fi Halli Ghayatil Ikhtisar*, Bairu: Darul Al-Khair, 1991.

¹⁴ Ahmad Izzuddin and M. Basthoni, *Using Commad Line...*, 79-91.

¹⁵ Ahmad Izzuddin, *Kajian Terhadap Metode-Metode Penentuan Arab Kiblat Dan Akurasiya* (Kementerian Agama Republik Indonesia, 2012).

¹⁶ Harry Ramza and others, 'Towards the Compilation of the Global Twilight Pattern', *Ulum Islamiyah*, 33.1 (2021), 71–83.

¹⁷ Mamduh Farhan al-Buhairi, 'Koreksi Awal Waktu Subuh', *Pustaka Qiblati*, 2010.

¹⁸ Pimpinan Pusat Muhammadiyah, 'Tanfidz Keputusan Muktamar Satu Abad Muhammadiyah', *Yogyakarta: Pimpinan Pusat Muhammadiyah*, 2010.

¹⁹ Pimpinan Pusat Muhammadiyah, *Surat Keputusan Pimpinan Pusat Muhammadiyah N0: 17 (SK-PP/II-A/1. A/2001 Tentang Tanfidz Keputusan Musyawarah Nasional Tarjih XXIV, 2001)*.

council's task was merely to select among various opinions within the Islamic intellectual tradition that were deemed to have the strongest foundation. This process is known as the Tarjih method²⁰. This is because Muhammadiyah itself does not adhere to a specific school of thought, especially the four well-known schools (Hanafi, Maliki, Shafi'i, and Hanbali) among Muslims. Furthermore, the evolution of society has led to an increasing number of complex issues. Consequently, the answers to these issues are not always found within the classical Islamic intellectual tradition. As a result, Muhammadiyah's concept of Tarjih has expanded to encompass efforts in seeking legal provisions for new issues that were not previously addressed by earlier scholars²¹. These efforts, particularly among scholars of *usul al-fiqh* (principles of Islamic jurisprudence), are more commonly known as *Ijtihad*²².

Majelis Tarjih and Tajdid Muhammadiyah in its operational activities, has three products: Tarjih Decisions, Tarjih Fatwas, and Tarjih Publications. Tarjih Decisions are decisions made through the Tarjih Congress/National Tarjih Consultation Forum. This category is conducted at least every five years. The results of Tarjih decisions, made during the National Consultation Forum, are binding for the leadership of Muhammadiyah at all levels of its organizational structure, including central, regional, district, branch, and local community levels²³. Tarjih Fatwa is a forum organized by the Central Leadership Team of Muhammadiyah's Tarjih

Council. This forum is established to respond to requests from various regions, districts, or individuals regarding Tarjih Fatwas related to issues faced by Muhammadiyah members that require immediate answers²⁴. Tarjih Publications include papers and book publications that are considered to provide insights into Islamic matters deemed relevant to the Majelis Tarjih. In terms of substantive content, both Tarjih Decisions and Tarjih Fatwas address various issues within Islam, ranging from matters of faith, worship, transactions, 'ulūm al-Quran, 'ulūm as-Sunnah al-Maqbulah, and various other issues²⁵.

Muhammadiyah, in every legal product, advocates the concept of "Islam Berkemajuan". This understanding perceives Muhammadiyah as an Islamic movement carrying the mission of propagation and reform to realize a virtuous Islamic society. Syafi'i Ma'arif²⁶ then continued by stating that the concept of "Islam Berkemajuan", especially in Indonesia, must be framed within the context of Indonesian identity and humanity²⁷. The goal of Islam is to guide this change, ensuring it does not deviate from the righteous path of Islamic essence, namely civilization, humanity, and justice. Islam should not be characterized by harshness, crudeness, terrorism, and radicalism²⁸. Furthermore, Muhammadiyah also characterizes itself as a *tajdid* movement²⁹. In its articles of association, it is stated that Muhammadiyah is an Islamic movement that engages in the propagation of virtue and prevention of vice, as well as *tajdid*³⁰. The *tajdid* embraced by

²⁰ Tim P P Muhammadiyah Majelis Tarjih, 'Tanya Jawab Agama 3, Cet. 4', *Yogyakarta: Suara Muhammadiyah*, 2012.

²¹ Muhammad Yusuf Amin Nugroho, 'Fiqh Al-Ikhtilaf: NU-Muhammadiyah', *Wonosobo: E-Book Free*, 2012.

²² Tasnim Rahman Fitra, Devrian Ali Putra, and Sukma Nada Desmanto, 'The Concept Of Wasatiyyah In Fiqh Muhammadiyah Perspective', *Aisy-Syari'ah*, 24.2 (2022), 253–68.

²³ PP Muhammadiyah, 'Keputusan Pimpinan Pusat Muhammadiyah Nomor 734/KEP/I.0/B/2021 Tentang Tanfidz Keputusan Musyawarah Nasional XXXI Tarjih Muhammadiyah Tentang Kriteria Awal Waktu Subuh', *PP Muhammadiyah (Yogyakarta: Suara Muhammadiyah)*, 2021).

²⁴ Sriyatin Shodiq, *Kapita Selekta Fatwa...*, 19.

²⁵ PP Muhammadiyah. Keputusan PP Muhammadiyah Nomor 734/KEP/I.0/B/2021.

²⁶ Muthoifin, 'Islam Berkemajuan Perspektif Ahmad Syafi'i Ma'arif: Studi Pemikiran Ahmad Syafi'i Ma'arif Tentang Islam Dalam Bingkai Keindonesiaan Dan Kemanusiaan', *Jurnal Wahana Akademika*, 4.1 (2017).

²⁷ Syamsul Arifin, Syafiq A Mughni, and Moh Nurhakim, 'The Idea of Progress: Meaning and Implications of Islam Berkemajuan in Muhammadiyah', *Al-Jami'ah: Journal of Islamic Studies*, 60.2 (2022), 547–84.

²⁸ Muthoifin., "Islam Berkemajuan....", 24.

²⁹ Tafsir, *Jalan Lain Muhammadiyah* (Banten: Al-Wasath, 2011).

³⁰ Pengurus Pusat Muhammadiyah, 'Anggaran Dasar Muhammadiyah', *Yogyakarta: Surya Sarana Grafika*, 2005.

Muhammadiyah is divided into purification and dynamism. Muhammadiyah positions itself as advocating moderate Islam or wasatiyah. Muhammadiyah is also oriented towards contemporary and future perspectives, which is now known as the concept of “*berkemajuan*”.

Changes in the Fajr Time Criteria from the Perspective of Muhammadiyah

Starting from the Sharia understanding related to Fajr as the determination of the beginning of the dawn prayer time, Muhammadiyah has been conducting its study for a very long time, approximately 20 years. It began with the publication of Sheikh Mamduh Farhan al-Buhairi's article titled "Salah Kaprah Waktu Subuh" in the Qiblati Magazine (2009). This article was then followed by the publication of the book authored by Agus Hasan Bashori et al. titled "Koreksi Awal Waktu Subuh"³¹. The Editor-in-Chief of Qiblati Magazine, Agus Hasan Bashori, then sent the first letter on July 31, 2009, to the Minister of Religious Affairs of the Republic of Indonesia. The second letter was sent on December 7, 2009, and the third letter on January 29, 2010, containing information related to the "Review of the Criteria for the Early Dawn Prayer Time." Not long after, the Director-General of Islamic Guidance at the Ministry of Religious Affairs (now the Ministry of Religious Affairs) on behalf of the Minister of Religious Affairs of the Republic of Indonesia responded to the letters from the Editor-in-Chief of Qiblati Magazine on November 9, 2009.

The discourse regarding the change in the criteria for the initial prayer time, as mentioned earlier, was followed up with the organization of the Working Consultation on Calculation and Observation (MUKER) by the Ministry of Religious Affairs of the Republic of Indonesia on August 3-4, 2009, at Hotel Horison Semarang. The discussion focused on "Fajr Time Reviewed from Sharia and Astronomical Evidence." In the subsequent developments, another Working Consultation on Calculation and Observation

³¹ Sriyatin Shodiq, Kapita Selektta Fatwa..., 19.

(MUKER) was held by the Ministry of Religious Affairs of the Republic of Indonesia on August 3-4, 2018, in Labuhanbajo Kupang. The agenda included discussions on calculation and observation, addressing topics such as "Fajr Time Reviewed from Sharia and Astronomy"³².

Internally, Muhammadiyah, through its Majelis Tarjih and Tajdid, then organized the 27th National Consultation Meeting (MUNAS) Tarjih in 2010 at Muhammadiyah University Malang with the theme "Kaji Ulang Awal Waktu Subuh". The participants did not reach a consensus on the initial Fajr time/dawn rising criteria, whether to maintain it at -20 degrees or change it to -18 degrees. As a result, the MUNAS decision retained the criteria at -20 degrees, as stated in the 2009 edition of the Muhammadiyah Hisab book. Over the following 10 years, from the 27th Tarjih MUNAS (2010) in Malang to the 31st Tarjih MUNAS (2020) in Gresik, Majelis Tarjih and Tajdid of Muhammadiyah appointed three Muhammadiyah-affiliated universities to conduct research/observation on the initial Fajr time/dawn rising, namely ISRN-UHAMKA Jakarta, Pastron-UAD Yogyakarta, and OIF-UMSU Medan³³.

The criteria of 20° for Fajr time were eventually revised based on the Decision of the Central Leadership of Muhammadiyah Number 734/KEP/I.0/B/2021 Regarding the Authorization of the Decision of the 31st National Consultation of Tarjih Muhammadiyah on the Criteria for the Beginning of Fajr Time to 18°. Muhammadiyah's basis for making this change includes, firstly, a Philological study of 29 Muslim astronomers who contributed their thoughts on the criteria for Fajr time through their works. This study resulted in data related to the thoughts of Muslim astronomy figures regarding the beginning of Fajr time with criteria

³² PP Muhammadiyah, Keputusan PP Muhammadiyah Nomor 734/KEP/I.0/B/2021.

³³ Sriyatin Shodiq, Kapita Selektta Fatwa, 19.

ranging from 17 to 20 degrees below the eastern horizon³⁴.

Through a Philological study of 29 Muslim astronomers, it is known that out of the 29 books explaining the height of the sun during Fajr time, none mentioned a height of -20° . The sun's height during Fajr time is expressed in numbers ranging from 17° - 19° below the eastern horizon.

Secondly, based on the results of Fajr observations conducted by the three internal institutions of Muhammadiyah. According to the recommendations of the 27th National Consultation of Tarjih on the 16th-19th of Rabiul Akhir 1431 H/ April 1-4, 2010, regarding the issue of the beginning of Fajr, Majelis Tarjih and Tajdid PP Muhammadiyah mandated the three institutions to conduct a study and observation of Fajr using a series of modern instruments and analytical methods to interpret the research results³⁵.

OIF UMSU (2021) utilized a Sky Quality Meter (SQM) to quantify changes in sky brightness (TKL). Data collection was carried out in the city of Medan, Pantai Romantis (Deli Serdang Regency), and Barus (Tapanuli Tengah Regency). The OIF research location is situated in an area with poor light pollution. Meanwhile, light pollution in Pantai Romantis and Barus locations is better than in OIF. Data collection duration spanned from 2017 to 2020 (Ramadan 1438 H - Zulkaidah 1441 H) with SQM directed at 0° , 30° , 45° , and 90° (zenith). The research results were processed using the Moving Average method. OIF UMSU concluded that the "best" data, according to OIF UMSU, is 16.48° ³⁶.

Pastron UAD also used an SQM directed at Zenith. Data collection was conducted in Bantul Regency, Yogyakarta City, Kulon Progo Regency, and Gunungkidul Regency. This research was

carried out in 2016 (Syakban 1437 H - Rabi'ul Awal 1438 H), 2017 (Rabi'ul Akhir 1438 H - Rabi'ul Akhir 1439 H), and 2020 (Syakban 1441 H). Pastron UAD concluded that the higher the light pollution, the later the Fajr time obtained from data processing. The lowest measured Sun elevation was -15.75° , and the data indicated that the Sun's elevation determining the Fajr time was higher than -18° ³⁷.

ISRN UHAMKA (2021) conducted research in several areas in Indonesia (Depok, Bogor, Bekasi, Tangerang, DKI Jakarta, Cirebon, Gunung Kidul, Labuanbajo, Bitung, Balikpapan, Manokwari) and abroad (England, the United States, Malaysia, Egypt, Turkey, and Saudi Arabia). Data collection was carried out from 2017-2020. ISRN concluded from 750 days of Fajr data (dawn data) from various regions worldwide, ranging from -18.4° , -18° , -17° , -16° , -15° , -14° , -13° , -12° , -11° , -10° , -9° , -8° , to -7° . ISRN's analysis even concluded that there is strong statistical evidence that dawn actually occurs when the Sun is at a position around -13° below the horizon. For Indonesia itself, the 99% confidence interval shows that the Subuh dawn ranges between -12.75° and -13.58° ³⁸.

In addition to the research results from the three internal institutions, the Muhammadiyah Central Board's Majelis Tarjih and Tajdid invited astronomy experts from the Bandung Institute of Technology, Dhani Herdiwijaya, and Mahasena Putra. The findings of their studies indicate that the majority of the Sun's altitude at the beginning of Subuh is minus 18° . Similar research results were presented by participants in the Munas Tarjih, such as Sugeng Riyadi, Bahrul Ulum, and Adi Damanhuri. Furthermore, a research paper titled "Reevaluation of The Sun's Altitude for Determination Beginning of Fajr Prayer Times in Malaysia" by Mohd Zambri Zainuddin et al. also

³⁴ P Muhammadiyah, *Keputusan Pimpinan Pusat Muhammadiyah Nomor 734/KEP/I (0/B/2021 tentang Tanfidz Keputusan Musyawarah Nasional XXXI Tarjih ...*, 2021).

³⁵ PP Muhammadiyah, *Keputusan PP Muhammadiyah Nomor 734/KEP/I.0/B/2021*.

³⁶ Arwin Juli Rakhmadi Butar-butur, *Data SQM*, 2020.

³⁷ Yudhiakto Pramudya, *Perkembangan Penelitian....*, 24-25.

³⁸ Tono Saksono, 'Global Twilight Project', in *Webinar Nasional Mengkaji Ulang Munculnya Fajar Di Indonesia Dan Dunia* (Jakarta: Universitas Muhammadiyah Prof. Dr. Hamka Jakarta, 2020).

concluded that the Sun's altitude at the beginning of Subuh is minus 18°. For comparison, several countries, including Turkey, England, France, Nigeria, and Malaysia, also use the criteria of the Sun's altitude at minus 18° for the beginning of Subuh³⁹.

What has been presented above indicates that the issue of determining the time of Fajr as the beginning of Subuh is a matter of *ijtihad*. Therefore, through a thorough study process, considering both the *syar'i* aspects and observational results according to the *Manhaj Tarjih* followed by the *Majelis Tarjih and Tajdid*, and taking into account the interests, the 31st *Tarjih National Conference* on the 14th of *Rabiul Akhir-5th of Jumadil Awal 1442 H/November 29–December 20, 2020*, established that the Sun's altitude at the beginning of Subuh is -18° on the eastern horizon.

The Relationship Between Science and Religion in the Decision of the Muhammadiyah Central Leadership Regarding Changes in the Criteria for the Beginning of Fajr Prayer Time

The context of the struggle between science and religion regarding the changes in the Fajr prayer time by Muhammadiyah actually falls into the realm of the study of the integration of knowledge, which has been a prolonged discussion. The struggle itself can be considered as a form of negation of integration, which, in its generic sense, is an effort to combine science and religion⁴⁰. Sudarminta once proposed what he referred to as "integrasi yang valid," but on another occasion, he criticized "integrasi yang naif", a term he used to describe the tendency to superficially match verses of the holy scriptures with scientific findings. This phenomenon is almost similar to the concept of *Bucailleism*,

which represents a defensive-apologetic attitude among some Muslim intellectuals⁴¹.

Ian Barbour, a Western Christian scientist, mapped the relationship between science and religion into four models: conflict, independence, dialogue, and integration. According to Zaenal Abidin Bagir, Barbour was consistent and serious in formulating these four typologies from his writings in the 1960s to the book he authored in 2002⁴². The typologies of conflict, independence, and dialogue proposed by Barbour seem incompatible with the study of science and religion in the context of changes in the Fajr time criteria from the perspective of Muhammadiyah. Muhammadiyah itself altered the criteria for Fajr time based on robust scientific reasons, particularly observed during the dawn (Fajr) phenomenon. The context of Fajr is a natural phenomenon mentioned in the Quran and Sunnah as a sign of the beginning of the Subuh prayer (Fajar Sadik) time. The scientific reason mentioned is that, with the criteria of -20 degrees, Fajar Sadik has not yet appeared⁴³. Moreover, Muhammadiyah's decision to change the criteria is also based on in-depth research by three institutions appointed to conduct scientific studies regarding the beginning of the Subuh prayer time. It is clear that the typologies of conflict, independence, and dialogue cannot represent how the integration of science and religion operates in this decision. These three typologies place science and religion in opposing positions, unlike how Muhammadiyah positions the relationship between science and religion in making this decision.

The fourth typology according to Barbour, namely the integration model, appears to be suitable for describing the relationship between science and religion in Muhammadiyah's decision. On one side, religion is an absolute truth, but on

³⁹ PP Muhammadiyah, Keputusan PP Muhammadiyah Nomor 734/KEP/I.0/B/2021.

⁴⁰ Liek Wilardjo Bagir, Arqom Kuswanjono, and Mohamad Yusuf, 'Ilmu, Etika & Agama, Menyingkap Tabir Alam Dan Manusia', *Yogyakarta: CRCs*, 2006.

⁴¹ Iis Arifudin, 'Integrasi Sains Dan Agama Serta Implikasinya Terhadap Pendidikan Islam', *Edukasia Islamika: Jurnal Pendidikan Islam*, 1.1 (2016), 161–79.

⁴² Bagir, Kuswanjono, and Yusuf, *Ilmu Etika...*, 2006.

⁴³ Mamduh Farhan al-Buhairi, *Koreksi Awal...*, 5-7.

the other side, science helps to describe and explain the truth of religion through its scientific approach⁴⁴. In another concept, science serves as a tool employed by religion to provide guidance on theoretical aspects outlined by the Sharia⁴⁵. This is in line with what Muhammadiyah has done in changing its decision regarding the beginning of the Fajr prayer time. The criteria for the Fajr prayer time altered by Muhammadiyah are scientifically described, illustrating the height of the Sun during dawn. As previously explained, Muhammadiyah clearly demonstrates the implementation of the concept of integration between religion and science in changing these criteria.

Regarding this, John Haught in his writings describes this science-religion relationship as a journey. Bagir interprets very well what Haught calls a journey. According to him, Haught's relational journey ends with what is called the confirmation model to find similarities between science and religion because fundamentally both areas have the same goal of achieving a true understanding of nature, allowing them to learn from each other and even collaborate⁴⁶. This is in line with the views of the Muslim intellectual from Turkey, M. Fethullah Gulen, who considers science and faith not only to be compatible but also complementary. Therefore, he encourages scientific research and technological development for the benefit of humanity⁴⁷. At a glance, this has already been applied by Muhammadiyah in its decision regarding the beginning of Fajr time.

⁴⁴ Bagir, Kuswanjono, and Yusuf, *Ilmu Etika...*, 2006.

⁴⁵ Syarif Hidayatullah, 'Relasi Agama Dan Sains Dalam Pandangan Mehdi Golshani', *Jurnal Filsafat*, 27.1 (2017), 65–90.

⁴⁶ Zainal Abidin Bagir, 'Sains Dan Agama-Agama: Perbandingan Beberapa Tipologi Mutakhir Dalam Zainal Abidin, Liek, Arqom, Dan M', *Yusuf (Eds.), Ilmu, Etika Dan Agama: Menyingkap Tabir Alam Dan Manusia*, Yogyakarta: CRCS UGM, 2006.

⁴⁷ Mutamakkin Billa, 'Pemaknaan Teologis M. Fethullah Gülen Tentang Relasi Agama Dan Sains', *Teosofi: Jurnal Tasawuf Dan Pemikiran Islam*, 1.2 (2011), 290–316.

Such an integration model is officially utilized by Muhammadiyah in making internal decisions⁴⁸.

The study of the science-religion relationship in the context of changing the Fajr prayer time has focused on the reality reflected in Muhammadiyah's decision. The initial criteria for the Fajr prayer time were altered to be 2 degrees higher than before, changing from -20 degrees to -18 degrees⁴⁹. It is true that the steps taken have followed the procedure like an integration between science and religion, where all scientific efforts are used to make this decision. However, upon reviewing the decision that has been established and considering the scientific research results from the institutions appointed by Muhammadiyah, a scientific discrepancy is evident⁵⁰.

The research results from the 3 internal institutions appointed by Muhammadiyah scientifically indicate that the trend towards the emergence of dawn at a solar depression is less than -18°. However, Muhammadiyah chose to adopt the -18° criteria. Disregarding the results of the research from these 3 institutions raises scientific doubts about the decision to change the criteria for the beginning of Fajr prayer time made by Muhammadiyah.

In response to this, Rahmadi Wibowo⁵¹ explained that Muhammadiyah's decision to adopt -18° was not solely based on the research results of the 3 appointed institutions but also considered

⁴⁸ Agus Purwanto, 'Meneguhkan Semangat Tajdid Muhammadiyah Dalam Implementasi Hisab/Falak Dan Iptek', *Pengajian Tarjih Muhammadiyah* (Yogyakarta: Majelis Tarjih dan Tajdid PP Muhammadiyah, 2021).

⁴⁹ PP Muhammadiyah, Keputusan PP Muhammadiyah Nomor 734/KEP/I.O/B/2021.

⁵⁰ The aspect of science in Indonesia is indeed not always consistently taken into account in the establishment of fatwas, especially related to falakiah, thus triggering various religious patterns in their interaction with science, ranging from conflict, independence, and dialogue, to integration Muhammad Rasyid and others, 'Scientific Consideration in the Concept of Islamic Law in Indonesia : A Study on The Fatwas of Falakiah Of MUI', *Al-Danlah: Jurnal Hukum Dan Perundangan Islam*, 13.2 (2023), 202–229 <<https://doi.org/10.15642/ad.2023.13.2.202-229>>.

⁵¹ Rahmadi Wibowo, 'Wawancara Dengan Tema Perubahan Kriteria Awal Waktu Shubuh Muhammadiyah (Pergulatan Sains-Agama)' (Yogyakarta, 2023).

various other studies presented during the MUNAS Tarjih. Apart from the research of these 3 internal institutions, the Central Board of Tarjih and Tajdid invited astronomy experts from the Bandung Institute of Technology, Dhani Herdiwijaya, and Mahasena Putra. The results of their studies indicate that the majority support a solar depression of -18° for the beginning of Fajr. Similar findings were presented by participants of the Tarjih Congress, such as Sugeng Riyadi, Bahrul Ulum, and Adi Damanhuri. Furthermore, a study titled "Reevaluation of The Sun's Altitude for Determination Beginning of Fajr Prayer Times in Malaysia" by Mohd Zambri Zainuddin et al. concluded that the solar depression for the beginning of Fajr is -18° . As a comparison, several countries also use a -18° solar depression criterion for the beginning of Fajr, such as Turkey, the United Kingdom, France, Nigeria, and Malaysia⁵².

The argumentation dismissing the research results above seems to suggest that the research conducted by the three institutions was merely used as a legitimization for raising the criterion from -20° to -18° , indicating that -18° was a predetermined figure and any research results presented by the three institutions would not change this number. Tono Saksono explained that indeed, during the MUNAS, the scientific aspect based on the research results of these three institutions was not the focus of the study but rather focused more on the theoretical-normative aspect and was dominated by figures who were not actually involved and did not understand the research results in detail⁵³.

This integration model seems to align with the expression of Langdan Gilhey, stating that science seeks to explain objective, general, and repetitive data, while religion talks about the existence of the order and beauty of the world and individual experiences such as forgiveness,

⁵² PP Muhammadiyah, Keputusan PP Muhammadiyah Nomor 734/KEP/I.O/B/2021.

⁵³ Tono Saksono, 'Wawancara Dengan Tema Perubahan Kriteria Awal Waktu Shubuh Muhammadiyah (Pergulatan Sains-Agama)' (Medan, 2023).

meaning, belief, salvation, and so on. No matter how much science demonstrates its existence, religious beliefs sometimes take a different path, at least science emerges and is positioned at a level that avoids conflict between the two⁵⁴. Especially when this understanding is within the framework of an organization with a set of dynamics within it. But it should be emphasized that it still remains within a strong foundation of integration⁵⁵.

The model of integrating science and religion, in its simplest form, is an attempt to combine science and religion but is exposed to other influences due to the dominance of power or authority in decision-making. This is in line with the statement by Laswell, Kaplan, and Van Doorn as cited by Miriam Budiardjo, which reveals that power is the ability to limit the action alternatives of an individual or group according to the goals of the first party. R.J. Mokken formulates the concept that power is the ability of an actor (an individual, group, or institution) to absolutely determine or alter (wholly or partially) the action alternatives or choice alternatives available to other actors⁵⁶. This reality at least indicates that in an organization, authority is a common and even determining factor in the produced outcomes, regardless of how the processes are conducted democratically and based on any arguments, including scientific ones⁵⁷.

The deliberation in MUNAS Tarjih indeed places its participants on an equal footing, at least as regulated in the session rules. However, the logical aspects of a deliberative meeting with this type of ambiguity and paradoxical authority

⁵⁴ Billa, Pemaknaan Teologis..., 290-316.

⁵⁵ Piotr Roszak and Saša Horvat, 'Overcoming Reductionism: Towards a New Model of Relations in Science--Religion', in *Overcoming Reductionism and Crafting a New Synthesis: Theodicy Confronting Pain and Suffering* (Cham: Springer Nature Switzerland, 2024), pp. 45–76 <https://doi.org/10.1007/978-3-031-62498-8_2>.

⁵⁶ Miriam Budiardjo, 'Aneka Pemikiran Tentang Kuasa Dan Wibawa, Sinar Harapan' (Jakarta, 1991).

⁵⁷ Ikechukwu Bernard and Kabiru Umar, 'Authority, Power, and Conflict in Organization: Analysis of the Impact of Their Functional Relationship In Organization Performance', 6 (2014), 174–84.

regulation can lead to the recognition of certain figures as "superpowers." The distribution of authority may not be carried out objectively and fairly, allowing the thoughts of these "superpower" figures to influence the outcomes of the deliberation⁵⁸. This is what happened during the 31th MUNAS Tarjih Regarding the Criteria for the Beginning of Fajr Prayer Times. This is a common occurrence and an integral part of the decision-making process in an organization. However, it has negative implications for the well-established concept of integrating knowledge⁵⁹.

Fitra⁶⁰ in his study on the concept of wasatiyah related to the decision to change the beginning of the Fajr prayer time by Muhammadiyah, reveals that through the principle of wasatiyyah, there is nothing wrong with the collective ijihad conducted by Muhammadiyah through a lengthy process until it was decided at the MUNAS. However, the issue lies in the principles of tawazun, ta'adul, and tawasuth in the decision-making process. Muhammadiyah did not use the research results of the appointed institutions fairly and equally. Furthermore, Muhammadiyah should have taken stock and considered other important research outside of Muhammadiyah to make the decision stronger and more convincing⁶¹.

The relationship between science and religion in the form of integration certainly cannot be implemented absolutely within an organization. Authority conflicts cannot be immediately justified as the cause of errors in the application

of the integration of science and religion within the Muhammadiyah organization. Therefore, Fayol explained in detail that an organization is the grouping of people into cooperative activities to achieve established goals, while organizing is the activity of grouping, arranging, and coordinating various tasks that need to be carried out to achieve those goals⁶². This is in line with Griffin's understanding that an organization assigns people to perform job functions to facilitate cooperative activities in achieving goals⁶³. Organizing, on the other hand, involves arranging and grouping various jobs based on job type, sequence of tasks, nature and function of jobs, time, and speed⁶⁴. So, in the dynamics of organizational behavior, the organization's goals are crucial, influencing the trajectory of the organization, including the products it produces.

Therefore, at the beginning of the 19th century, the "traditional theory" or also called the "machine theory" of organizations developed. In this theory, organizations are depicted as centralized institutions with specialized tasks, providing rigid mechanistic structural guidance without creativity⁶⁵. This theory even considers an organization as a container without creativity, where members merely perform rigid mechanistic structural functions. Modern Organization Theory views all organizational elements as an interconnected unity that cannot be separated. An organization is not a closed system associated with a stable environment; instead, it is an open system connected to the environment. For survival, it must adapt to its surroundings⁶⁶. This explanation indicates that in an organization, there are other aspects that must be considered as the main focus, namely how an organization survives, by providing rules and figures that act as "guides"

⁵⁸ Salman Luthan, 'Hubungan Hukum Dan Kekuasaan', *Jurnal Hukum IUS QULA IUSTUM*, 14.2 (2007).

⁵⁹ María Soria-Oliver, Jorge S López, and Fermín Torrano, 'Relations between Mental Workload and Decision-Making in an Organizational Setting', *Psicología: Reflexão e Crítica*, 30.1 (2017), 7 <<https://doi.org/10.1186/s41155-017-0061-0>>.

⁶⁰ Fitra and Silvana, *Moderate Islamic Jurisprudence*, 69-70.

⁶¹ Marzuki Umar and others, 'Perspectives from Islamic Law on the Muhammadiyah Central Leadership's Tarjih Council and Its Significance for Religious Moderation', *Journal of Modern Islamic Studies and Civilization*, 2.01 SE-Articles (2023), 78-93 <<https://doi.org/10.59653/jmisc.v2i01.517>>.

⁶² Henry Fayol, 'Industri Dan Manajemen Umum', *Terj. Winardi. London: Sir Issac and Son*, 1985.

⁶³ E A Griffin, A Ledbetter, and G G Sparks, *A First Look at Communication Theory*, McGraw Hill Education (New York: McGraw-Hill Education, 2015).

⁶⁴ Griffin, Ledbetter, and Sparks.

⁶⁵ Leonardo Budi Hasiholan, 'Teori Organisasi Suatu Tinjauan Perspektif Sejarah', *Dinamika Sains*, 10.24 (2012).

⁶⁶ Hasiholan, *Teori Organisasi...*, 2012.

to ensure that the organization stays within its own framework.

The reality of this situation influences every decision in Muhammadiyah. The *Manhaj Tarjih*, as the standard foundation for every decision of the Majelis Tarjih and Tajdid PP Muhammadiyah, fundamentally mandates the integration of science and religion (Islam), and this is indeed implemented in every decision made by Muhammadiyah, especially the Majelis Tarjih. Various methods are used, including the *bayani* method (interpretation method), causation method, both based on efficient and final causation (*maqāṣid asy-syarīah*), and synchronization method in the case of *ta'arudh*⁶⁷.

Furthermore, Azhari explains that the considerations for changing the criteria for the initial time of Fajr in the 31st MUNAS Tarjih already encompass aspects of *hadharatun nash*, *hadharatun 'ilm*, and *hadharatun falsafah* in accordance with the *Manhaj Tarjih* and *Mashlahah*⁶⁸. The aspect of *Hadharatun Nash* is considered fulfilled with the legal studies, as explained in the previous sections. The aspect of *Hadharatun 'Ilm* is also deemed fulfilled with philological and astronomical studies over decades. The aspect of *Hadharatun Falsafah* perceives the validity of truth as intersubjective, and the role of reason is participatory. Thus, the *'irfani* approach, relying on the instruments of inner experience and intuition, needs to be internalized in every decision⁶⁹. Therefore, organizationally, the decision to change the criteria to -18 degrees is actually appropriate if Muhammadiyah is consistent with its *Manhaj Tarjih*.

The aspect of *Hadharatun 'Ilm*, in this case, comes under scrutiny, as subjectively there might be choices if there are several research results showing different outcomes. However, this is answered by implementing the *'irfani* approach, where inner experiences and intuition will lead to

the conclusion that -18 is the most logical value for the sake of public welfare. A difference of 2 degrees would result in an 8-minute difference with the conventional Fajr prayer schedule "version" of the Indonesian Ministry of Religious Affairs. The consequence of this change is the potential conflict that may arise in society⁷⁰. On one hand, Muhammadiyah cannot persist with the old criteria, which, according to Muhammadiyah itself, have been scientifically disproven. Therefore, inevitably, these criteria have to be changed. Thus, choosing the value of -18 is a scientific decision and, at the same time, a way to minimize the potential conflicts. Additionally, this value has already been used by other Islamic countries such as Turkey, the United Kingdom, France, Nigeria, and Malaysia.

Conclusion

Muhammadiyah's decision regarding the change in the criteria for the early morning prayer time signifies a shift from the previous criteria of the sun's elevation during dawn being -20 degrees to -18 degrees. This change was based on research findings on the dawn time by ISRN UHAMKA (-13°), OIF UMSU (-16.48°), and PASTRON UAD (less than -18°), along with considerations from other studies presented by Muhammadiyah cadres during the 31st MUNAS. Additionally, philological studies of 29 fiqh books related to the early morning prayer time and investigations into the application of the sun's elevation during dawn by other Muslim countries were taken into account. The primary consideration, of course, was based on the Quranic verses and Hadiths as the fundamental basis for determining the time of the Fajr prayer. This situation indicates a struggle between science and religion, especially when the sun's elevation values obtained through the research of the three officially appointed institutions by Muhammadiyah were not strictly utilized.

⁶⁷Syamsul Anwar, 'Manhaj Tarjih Muhammadiyah', *Yogyakarta: Gramasurya*, 2018.

⁶⁸ Susiknan Azhari, 'Memahami Koreksi Waktu Subuh', *Republika*, 2021, pp. 1-3.

⁶⁹ Anwar, *Manhaj Tarjih*..., 2018.

⁷⁰ Fitra and Silvana, *Moderate Islamic Jurisprudence*, 69-70.

The conflict between science and religion in the decision of the Central Board of Muhammadiyah regarding the change in the criteria for the subuh prayer time does not necessarily imply that religion and science are incompatible. Instead, this situation aligns with Ian Barbour's typology of science-religion integration, which aims to reconcile science and religion comprehensively. As an organization, Muhammadiyah naturally adheres to a set of rules to achieve its goals, implying that science does not necessarily have to be utilized entirely⁷¹. The considerations for the change in the criteria for the early morning prayer time during the 31st MUNAS Tarjih encompassed aspects of *badharatun nash*, *badharatul 'ilm*, and *badharatul falsafah* according to the Tarjih's method and considerations for the greater good⁷². Muhammadiyah chose the value of -18 degrees based on the application of *'irfani* approach to achieve the greater good. Nevertheless, it still indicates that Muhammadiyah is not consistent in utilizing the discourse on changing the criteria for the initial time of Muhammadiyah's Fajr prayer for greater good. Nevertheless, it still indicates that Muhammadiyah is not consistent in utilizing

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⁷¹ Ingunn Ý Guðbrandsdóttir and Guðmundur V Oddsson, 'Productivity in an Organizational Setting: A Systematic View of the Causalities at Work', *Administrative Sciences*, 2022 <<https://doi.org/10.3390/admsci12030090>>.

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