

Systemic Quantification And Cascading Biorefinery Engineering Of School Meal Plate Waste

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ABSTRACT

School feeding programs generate large volumes of plate waste, yet most decentralized programs cannot produce comparable and auditable measurements of what is served, consumed, and discarded. Existing research on food-waste measurement, waste valorization, and sustainability assessment has developed largely as separate streams. This study develops and documents an auditable four-layer framework that links standardized Edge AI computer-vision quantification of school meal plate waste with material characterization, a five-stream cascading bio-valorization pathway, and system-level evaluation, within Indonesia's Makan Bergizi Gratis (MBG) program. The quantitative, engineering based design covers 50 schools in East Java across five operational zones and 1,200 matched tray pairs, with image-based mass estimates validated against physical scale weights using R^2 , MAE, and MAPE. Waste fractions are characterized through proximate and ultimate analysis and routed to biodiesel, hydroxyapatite, black soldier fly larvae bioconversion, anaerobic digestion, and biochar-compost. Life-cycle and techno economic assessments evaluate the system at a 10 ton/day regional scale. The analysis indicates that standardization at the data-acquisition stage improves downstream comparability and that measured fractions can be linked to differentiated recovery pathways. The numerical results are project reported, the sampling frame is limited to East Java, and the LCA and TEA outputs remain scenario dependent.

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1. INTRODUCTION

School feeding programs are increasingly understood as instruments of nutrition, education, and social protection, yet the scale at which they operate also makes them a significant source of food loss (Cohen et al., 2014; Verguet et al., 2020). An unfinished school meal is easy to see and difficult to quantify: a spoonful of rice, a piece of chicken, or vegetables left at the edge of a tray may

look insignificant at the individual level, but at program scale repeated leftovers become a stream of material, nutrients, public expenditure, operational information, and environmental burden (Niaki et al., 2017; Smith & Cunningham-Sabo, 2014). In Indonesia, the Makan Bergizi Gratis (MBG) program brings this issue into sharp focus because meals are prepared and distributed at very large beneficiary scale (Abadi et al., 2025; Suprpto et al., 2025). The research problem therefore begins not at the landfill, but at the plate.

The consequences of plate waste span at least four dimensions. Nutritionally, food that remains on the plate was procured, prepared, transported, and served but not consumed, so the dietary benefit of the program is reduced (Cohen et al., 2014; Smith & Cunningham-Sabo, 2014). Economically, every meal carries costs for ingredients, labor, energy, packaging, and logistics, and a portion of this expenditure fails to generate the intended benefit (Verguet et al., 2020). Environmentally, poorly managed organic residues emit methane and other greenhouse gases, even though the same residues contain recoverable carbon, nutrients, lipids, and minerals (Bernstad & la Cour Jansen, 2012; Lin et al., 2013). Informationally, menu acceptance is a data problem rather than only a communication problem, because without standardized measurement repeated leftovers remain anecdotal (Abadi et al., 2025; Niaki et al., 2017).

Despite this importance, a significant gap persists between the ideal of evidence-based school-meal management and measurement practice in the field. Traditional gravimetric audits provide direct reference weights but are labor intensive and difficult to scale across many schools and repeated observations (Smith & Cunningham-Sabo, 2014; Williamson et al., 2003). Visual estimation reduces the operational burden but introduces observer variability (Swanson, 2008; Williamson et al., 2003). Computer vision can automate measurement, yet its performance tends to deteriorate when cameras, lighting, tray geometry, and food appearance vary across sites (Lo et al., 2020; Tahir & Loo, 2021). As a result, many decentralized school networks cannot yet produce comparable and auditable measurements of what is served, consumed, and discarded.

A second body of research addresses waste characterization and valorization. Studies on food waste conversion through Black Soldier Fly Larvae (BSFL), anaerobic digestion, composting, biodiesel production, and mineral recovery have demonstrated technically efficient pathways (Canakci, 2007; Diener et al., 2009; Kareem & Eyiler, 2024; Zhang et al., 2007). However, such work usually optimizes a single feedstock or conversion route, whereas any recovery pathway requires an upstream estimate of the quantity and composition of the material. A technically efficient bioreactor has limited operational value if the feedstock supply is unknown or highly variable (Lin et al., 2013; Zhang et al., 2007). A third body of research uses life-cycle assessment (LCA) and techno-economic assessment (TEA) to compare environmental and economic scenarios, but these assessments depend on system boundaries, functional units, yields, and substitution credits, and become more decision-relevant only when connected to an auditable measurement layer (Bernstad & la Cour Jansen, 2012; Salomone et al., 2017).

Although many studies have examined food-waste measurement, valorization technologies, and sustainability assessment, they have largely developed as separate literature streams, and the approach taken is often partial rather than integrated (Bernstad & la Cour Jansen, 2012; Lin et al., 2013). Few studies connect standardized plate-waste quantification with material characterization, cascading recovery, and system-level evaluation within a single framework, particularly for a national school-meal context such as MBG (Abadi et al., 2025; Suprpto et al., 2025). The gap addressed here is therefore integration. The novelty proposed by this study does not lie in the claim that computer vision, BSFL, biodiesel, biogas, composting, or LCA are individually new, but in an integrated architecture in which standardized measurement supplies the quantity signal, characterization supplies the material-quality signal, cascading valorization supplies recovery options, and LCA/TEA translate those options into system-level evidence.

This study develops that architecture as a four-layer framework. The first layer is sensing, consisting of standardized tray geometry, reference markers, color calibration, and controlled image capture. The third is material intelligence, in which food-category and chemical characterization determine the suitability of different recovery routes. framework deliberately avoids a single 'food waste' bucket, because used cooking oil, cooked rice, eggshells, and wet organic residues behave differently and should be routed to distinct pathways before residuals are combined (Lin et al., 2013; Zhang et al., 2007). Communication is treated as an enabling layer across the architecture, since engineers, nutrition analysts, school kitchens, sustainability teams, and decision makers each need data that can be interpreted in their own operational context (Aschemann-Witzel et al., 2015; Abadi et al., 2025).

The main argument proposed is that standardization at the data acquisition stage improves downstream comparability, because an AI model cannot fully correct systematic variation introduced by uncontrolled geometry, lighting, and color response (Lo et al., 2020; Tahir & Loo, 2021). The manuscript therefore follows a clear sequence: observe the unfinished plate, measure it consistently, understand what is in it, route each fraction to a suitable recovery pathway, and return the information to program decision makers. This sequence positions the work as an integrated resource-management study rather than an isolated computer vision application.

Finally, this study contributes an end-to-end architecture and an explicit evidence-status framework. Project-reported benchmarks are separated from independently verified observations, model outputs are separated from measured values, and future validation requirements are stated rather than hidden. In this way, the study not only enriches the literature on circular bioeconomy and sustainability communication, but also offers a practical basis for turning plate waste from a disposal endpoint into a feedback signal for school meal programs.

2. METHODS

This study employs a quantitative, engineering-based approach integrating field measurements, laboratory characterization, and scenario-based system assessment to develop an auditable framework linking Edge AI computer-vision quantification of school-meal plate waste with material characterization and five-stream cascading bio-valorization within Indonesia's Makan Bergizi Gratis (MBG) program. Data were collected from 50 schools across five operational zones in East Java metropolitan, coastal, agricultural, mountainous, and industrial using 1,200 matched post-meal tray observations, each comprising standardized images, reference scale weights, and contextual metadata (Muthmainnah et al., 2025). Image acquisition employed ArUco fiducial markers and X-Rite color calibration, with quality thresholds of device tilt below 15°, illumination of at least 150 lux, and detection of all four markers (Garrido-Jurado et al., 2014). Image processing involved segmentation, depth reconstruction, and density-aware mass estimation ($M_i = q_i V_i (1 - \omega_i)$), validated against gravimetric measurements using R^2 , MAE, and MAPE (Lo et al., 2018). Waste composition was assessed through proximate and ultimate analyses before allocation to five recovery pathways: used cooking oil for biodiesel (Yaakob et al., 2013), eggshells for hydroxyapatite (Kareem & Eyiler, 2024), protein- and carbohydrate-rich residues for black soldier fly larvae conversion assessed using the waste reduction index (Naser El Deen et al., 2023), wet organic waste for anaerobic digestion (Morales-Polo et al., 2018), and residual materials for biochar-compost production. Environmental and economic feasibility were evaluated through life-cycle assessment, using 1.0 ton of waste as the functional unit and landfill disposal as the baseline, and techno-economic assessment of a 10-ton/day regional facility (Mertenat et al., 2019). Findings were presented through conceptual diagrams, validation charts, and comparative tables, with evidence classified as directly measured, validated model output, scenario-derived, or literature-supported

assumptions. The analysis indicates that standardized data acquisition improves measurement comparability and supports differentiated waste recovery pathways. However, its findings remain constrained by independently unverified project-reported numerical results, East Java-specific sampling, and scenario-dependent environmental and economic estimates.

3. FINDINGS AND DISCUSSION

Syed Muhammad Naquib al-Attas and Ismail Raji al-Faruqi are two key figures who played a significant role in formulating the paradigm of modern Islamic education, particularly in responding to the epistemological challenges arising from the dominance of the Western secular paradigm. Although both are working to address the crisis, their approach contains methodological and conceptual differences. Al-Attas proposes a profound critique of the secularization of science through the concept of Islamization of science that focuses on *adab*. In his work *Islam and Secularism*, al-Attas states that science cannot be separated from the underlying moral and ontological values, so knowledge must be channeled with spiritual meaning to form civilized and moral individuals (Puspitasari & Arifi, 2025).

On the other hand, al-Faruqi offers an epistemological reconstruction approach that prioritizes the systematic integration of modern science with revelation. Through the work *Islamization of Knowledge*, he emphasized the need to empower Islamic education with the principle of monotheism as the basis for restoring harmony between knowledge and spirituality (Sunarti & Rahman, 2025; Afandi, 2025). An in-depth analysis of the main works of these two thinkers reveals a major pattern in their thinking: al-Attas directs attention to the importance of the formation of *adab* as a central aspect of education, while al-Faruqi is oriented towards integrating knowledge with Islamic values in order to create a complete and comprehensive education system.

With the synthesis between al-Attas and al-Faruqi's thoughts, it is possible to build an Islamic education model that not only functions due to knowledge transfer, but also as a vehicle for integrative character formation, able to balance between science and faith in facing the challenges of modernity (Sunarti & Rahman, 2025; Nisa, 2025). In line with that, the findings of this study will contribute to the development of a monotheistic and *adab*-based education paradigm that is relevant to the needs of the current Muslim community (Qiso et al., 2025; Wiryanto, 2016).

Ismail Raji al-Faruqi places the main focus on the phenomenon of the dichotomy of science that has undermined epistemic unity in the Muslim world, especially in the context of the separation between religious science and modern science. In his seminal work, *Islamization of Knowledge*, al-Faruqi emphasizes the urgent need to Islamize science as a systematic project that aims to reconstruct various modern disciplines to be in harmony with the principles of monotheism. In contrast to Syed Muhammad Naquib al-Attas's approach which emphasizes the refinement of key concepts in the discipline, al-Faruqi emphasizes structural and institutional integration between revelation and modern scientific rationality. He argues that monotheism is not only a theological doctrine, but also a methodological principle that underlies the entire process of knowledge production, starting from the basic assumptions used to the social purpose of the science (Husni, 2025).

On the contrary, al-Faruqi is more operational and programmatic, encompassing concrete steps to implement the Islamization of science through the restructuring of curriculum, research, and educational institutions. Thus, this distinction confirms that al-Attas focuses on theory and conceptual foundations, while al-Faruqi emphasizes more practical application at the level of educational institutions (Griffo et al., 2019). In terms of educational goals, al-Attas proposes the attainment of a complete human being (*insan kamil*) who is not only civilized, but also realizes his metaphysical responsibility as the caliph of Allah on earth. Education, according to him, must be directed to introduce students to God, themselves, and the universe in an integrated manner.

On the other hand, al-Faruqi emphasized the importance of forming a generation of Muslims who not only master modern science, but are also able to use this knowledge for the social transformation of the *ummah* based on the principles of justice and benefit. Therefore, in al-Faruqi's

perspective, the purpose of Islamic education has a more explicit social-reformative orientation, making it relevant to the ever-changing needs of society (Ilic et al., 2012). Despite differences in methodology and orientation, the thoughts of al-Attas and al-Faruqi cannot be considered contradictory. On the contrary, the two complement each other in an effort to restore the sacredness of knowledge, as well as to affirm monotheism as the epistemological principle of Islamic education.

Al-Attas provides a strong philosophical basis through the concept of *adab* and criticism of the secularization of knowledge, while al-Faruqi provides an operational framework for integrating modern science into the framework of Islamic thought. By synthesizing these two approaches, it is hoped that an Islamic education paradigm can be formulated that is not only epistemologically robust, but also socially and institutionally relevant in the face of the increasingly complex challenges of modernity.

Thus, a critical analysis of the thought of al-Attas and al-Faruqi provides a richer perspective in understanding the challenges of Islamic education today. Both offer an important contribution to redefining and revitalizing Islamic education, in order to be able to compete with the global education paradigm that tends to be secular (Budiarti & Kurniati, 2024). By being based on the principles of monotheism and manners, Islamic education can produce individuals who are not only intellectually intelligent, but also superior in morals and spirituality (Zhang & Cao, 2021).

A comparative analysis of the thought of Syed Muhammad Naquib al-Attas and Ismail Raji al-Faruqi reveals a fundamental similarity in their epistemological anxieties regarding the dominance of the Western secular paradigm in science and education. Although both agree that the crisis of modern Islamic education has deeper roots than just technical and pedagogical challenges, they present a variety of conceptual paths in responding to these issues. Both underline that the crisis actually lies in epistemological errors regarding the nature of science, humans, and the purpose of education. Therefore, a comparative analysis of the epistemological aspects and the goals of Islamic education becomes relevant to delve deeper into their ideas (Amir & Rahman, 2023). Table 1 summarizes the main points of comparison discussed below.

Aspect	Al-Attas	Al-Faruqi
Epistemology	Science is bound to a worldview, so no knowledge is value-neutral; critique of the secularization of science	Systematic integration of revelation and modern scientific rationality through reconstruction of the basic assumptions of each discipline
Approach	Philosophical-hermeneutic; purification of meaning (<i>tashfiyah al-ma'na</i>)	Operational and programmatic; structural and institutional
Focus	Refinement of key concepts such as science, humanity, freedom, and progress	Islamization of knowledge as a systematic project across disciplines
Educational goal	Civilized person (<i>insan adib</i>) and complete human being (<i>insan kamil</i>)	Generation of Muslims who master modern science and use it for social transformation based on justice and benefit
Implementation	Philosophical and conceptual foundation; curriculum based on a hierarchy of knowledge	Restructuring of curriculum, research methodologies, teaching materials, and educational institutions

Table 1. Comparison of the Thought of al-Attas and al-Faruqi

Aspect Al-Attas Al-Faruqi Epistemology Science is bound to a worldview, so no knowledge is value-neutral; critique of the secularization of science Systematic integration of revelation and modern scientific rationality through reconstruction of the basic assumptions of each discipline Approach Philosophical-hermeneutic; purification of meaning (*tashfiyah al-ma'na*) Operational and programmatic; structural and institutional Focus Refinement of key concepts such as science, humanity, freedom, and progress Islamization of knowledge as a systematic project across

disciplines Educational goal Civilized person (*insan adib*) and complete human being (*insan kamil*)

Generation of Muslims who master modern science and use it for social transformation based on justice and benefit Implementation philosophical and conceptual foundation; curriculum based on a hierarchy of knowledge Restructuring of curriculum, research methodologies, teaching materials, and educational institutions From an epistemological perspective, al-Attas argues that science is an entity that is closely related to a certain worldview, so there is no value-neutral knowledge (Fadly, 2023). In his view, the criticism of the secularization of science underscores the revocation of the metaphysical and ethical dimensions of modern knowledge, which leads to a void of values in education (Masnila, 2025).

Al-Attas emphasizes that Islamic epistemology must build an integration between revelation, reason, and intuition within a framework of monotheism as an ontological and epistemological basis (Sunarti & Rahman, 2025). Therefore, understanding and purifying the meaning of fundamental concepts such as science, freedom, and progress is a crucial first step to redefining Islamic education (Fadliah, 2022). On the other hand, al-Faruqi highlighted practical steps for the Islamization of knowledge, emphasizing the need for the integration of science intertwined with Islamic principles to build a complete understanding of the world (Pratiwi et al., 2023). Despite the common ground in their initial views, both al-Attas and al-Faruqi took different paths in overcoming the challenges facing the world of Islamic education. Al-Attas, in his philosophical-hermeneutic approach, emphasizes the importance of refining key concepts so that Islamic education can be fundamentally transformed (Oktarini et al., 2025).

His approach is more theoretical and philosophical, focusing on the reform of thought and the purification of meaning. In contrast, al-Faruqi proposed a systematic model for the implementation of the Islamization of knowledge, which included specific measures to intertwine Islamic education with essential Islamic values (Bistara, 2022). This reflects the methodological differences between the two, where al-Faruqi focuses more on pragmatic applications in the education system. These two thinkers show that the crisis of modern Islamic education is not only a technical problem, but also a deeper challenge of values that must be faced with a more holistic and integrative approach (Mahomedya & Zahrah, 2022).

In this context, the importance of building Islamic educational principles that are not only based on technical progress but also on spiritual and ethical values has become very prominent. Research that brings together the ideas of al-Attas and al-Faruqi can make a significant contribution to the development of an Islamic education system that is more relevant and adaptive to contemporary standards (Yafiz & Daulay, 2023). Therefore, efforts to summarize and explore these ideas in the educational curriculum will also be a vital step to face the challenges of education in the era of modernity and globalization.

In the context of the development of Islamic epistemology, Ismail Raji al-Faruqi and Syed Muhammad Naquib al-Attas offer two different but complementary approaches in formulating the concept of Islamic education. Al-Faruqi emphatically highlights the problem of the dichotomy of science that has been rooted in the Muslim scientific tradition, namely the separation between religious science and modern science. He argued that this separation was a colonial legacy that negatively impacted the ability of Muslims to develop a comprehensive scientific tradition. In this context, al-Faruqi asserts that monotheism should not only be a theological doctrine, but also a comprehensive methodological principle, integrating revelation with modern scientific rationality in every discipline (Habibi, 2024).

Islamic epistemology developed by al-Faruqi aims to build a systematic integration between revelation and rationality, through the reconstruction of the basic assumptions and methodologies of each discipline (Fadly, 2023). He proposed that Islamic education should target the Muslim generation who not only master modern science, but are also able to use that knowledge to transform society in accordance with the principles of justice and benefit. In his view, education is not just to form a pious individual personally, but also as a means to form social actors who are responsible for reconstructing the order of modern civilization to be in harmony with Islamic values

(Husni, 2022). This step shows a praxis orientation in education, which focuses not only on individual achievement but also on broader social responsibility.

The fundamental difference between al-Faruqi and al-Attas' approaches lies in the focus of Islamic educational goals. Al-Attas emphasizes the formation of civilized people (*insan adib*) as the fundamental goal of education, with the hope that human beings will be introduced to their positions and responsibilities in the cosmic and social order according to the principles of monotheism (Susanti et al., 2024). He argued that education should not be reduced to a pragmatic tool for economic gain, but should be directed towards the realization of a complete human being (*insan kamil*) who is aware of his spiritual responsibility as the caliph of Allah on earth. Thus, it can be concluded that these differences reflect two complementary orientations: al-Attas with a focus on the achievement of spiritual and moral qualities, while al-Faruqi emphasizes more on transformational social action (Puspitasari & Yuliana, 2022).

Despite the differences in methodology and orientation, the thoughts of Syed Muhammad Naquib al-Attas and Ismail Raji al-Faruqi in the context of Islamic education are complementary and not contradictory. Both emphasize the importance of monotheism as an epistemological and normative basis, and seek to restore the sacredness of science that has been reduced within the modern secular framework. Al-Attas offers a strong philosophical foundation through his critique of the secularization of science as well as the emphasis on the concept of *adab* as a crucial epistemological category. On the other hand, al-Faruqi provides a more applicable operational framework for the reconstruction of modern disciplines and education systems that are in harmony with the values of monotheism (Yafiz & Daulay, 2023).

By synthesizing the approaches of al-Attas and al-Faruqi, an integral Islamic education paradigm is obtained. This paradigm has a solid epistemological foundation through conceptual refinement as offered by al-Attas, as well as the socio-institutional relevance to the structural integration approach of modern science as advocated by al-Faruqi (Daulay et al., 2023). This educational paradigm allows Islamic education to function as a tool for the formation of civilized people and as an instrument of civilization transformation that answers the challenges of modernity without losing its monotheistic roots. Through this collaboration of thoughts, comparative analysis confirms that the epistemological dialogue between the two can be used as a strategic foundation in redefining the direction of Islamic education today (Qudus & Syafri, 2021)

DISCUSSION

The thinking of Syed Muhammad Naquib al-Attas and Ismail Raji al-Faruqi carries profound theoretical and praxial implications in the development of contemporary Islamic education, especially in responding to the epistemological crisis caused by the dominance of the Western secular paradigm. Al-Attas, with his approach, affirms that science is not neutral in value, but is always related to a particular worldview. This shows that the Islamic education system cannot simply adopt a modern curriculum without making a deep critique of the ontological and methodological assumptions that underlie the thinking (Sunarti & Rahman, 2025).

In this process, Islamic education is required to undergo purification of meaning (*tashfiyah al-ma'na*) of the key concepts of knowledge in order to be in harmony with the principles of monotheism. Meanwhile, al-Faruqi emphasized that the goal of Islamic education must go beyond instrumental and utilitarian approaches by raising the issue of social justice and the benefit of the *ummah* as important elements in the educational process (Sunarti & Rahman, 2025). Thus, these two thinkers are based on the same foundation but with different focuses, which complement each other in the effort to reconstruct relevant Islamic education in the modern era.

The second implication of their thinking is the formulation of the normative goals of Islamic education. Al-Attas focuses on the formation of civilized people (*insan adib*) as the primary target of education, making it more than just an instrument for social mobility or the improvement of technical skills. According to him, education must integrate spiritual, intellectual, and moral

dimensions to produce a complete and harmonious personality (Ammar, 2023). On the other hand, al-Faruqi broadens the horizons of educational goals by emphasizing a social-transformative orientation that seeks to shape a generation of Muslims who not only master modern knowledge, but also use it ethically (Khikmatun, 2025). By combining the ethical-metaphysical dimension with the practical-sociological aspect, the purpose of Islamic education acquires a wider depth, makes it relevant in both spiritual and social contexts, and is stronger in facing the challenges of the times (Sunarti & Rahman, 2025).

The thoughts of Syed Muhammad Naquib al-Attas and Ismail Raji al-Faruqi carry important implications regarding the structure of the curriculum and pedagogical approaches in Islamic education. Al-Attas emphasized the importance of developing a curriculum based on a hierarchy of knowledge that reflects cosmic order in the Islamic view. In this framework, knowledge sourced from revelation occupies a central position as a guide for value orientation in education.

This implication requires substantial integration between religious and general sciences, not just administrative mergers. This is directly related to efforts to purify the meaning (*tashfiyah al-ma'na*) of key concepts in science to be in accordance with the principles of monotheism and the goals of Islamic education that are more integral and comprehensive (Sassi, 2022). Meanwhile, al-Faruqi offers an operational framework for the Islamization of science that demands the restructuring of curriculum, research methodologies, and teaching materials, so that the popular scientific disciplines can be reconstructed based on the principle of monotheism. He stated that Islamic education needs to go beyond simply incorporating Islamic content into modern subjects, but also revise the theoretical and methodological assumptions underlying the discipline.

With the perspective presented by al-Faruqi, the design of an integrative curriculum will involve efforts to create synergies between various disciplines and strengthen a solid epistemological base (Sumiran, 2025). Education that thus it is expected to form individuals who not only have good technical skills, but are also able to apply strong moral principles in their life decisions (Muaz et al., 2023).

The next implication concerns the institutional management of Islamic education, which demands the development of institutions that function as a center not only in the transmission of knowledge but also as a vehicle for the formation of a monotheistic worldview. Within this framework, Islamic educational institutions are required to develop an academic culture that respects scientific manners, scientific ethos, and moral responsibility. Al-Faruqi further explained that the institution must play an active role in the production of knowledge, through interdisciplinary research that focuses on solving the problems of the people and the global community. In this way, Islamic education not only functions as a static entity in presenting knowledge, but also as a dynamic force in responding to contemporary challenges (Coil & Aprison, 2023).

Furthermore, the contextual relevance of al-Attas and al-Faruqi's thoughts in the setting of Islamic education in Indonesia is very important. The education system that is still dualistic between religious science and general science has the potential to produce graduates who are less prepared to face increasingly complex global challenges. Therefore, the integrative concept based on monotheism and *adab* offered by these two figures can be used as a basis for reforming the curriculum, improving the epistemological competence of educators, and strengthening the institutional vision rooted in Islamic values. In this context, the application of these ideas is expected to be able to direct Islamic education towards a more holistic model, integrating scientific rationality with deeper spirituality, so that it can compete in the global arena without neglecting its spiritual essence (Nisok, 2024).

The thoughts of Syed Muhammad Naquib al-Attas and Ismail Raji al-Faruqi provide a solid foundation for the development of Islamic education that is responsive and relevant to the

challenges of the times. Taking into account aspects of curriculum, pedagogy, institutional management, and contextual relevance, these two figures propose an educational model that not only emphasizes cognitive and practical aspects, but also builds strong character and morals as future Muslim generations. In order to create a dynamic and contextual education, there is an urgent need to apply the principles proposed by al-Attas and al-Faruqi in all aspects of Islamic education. Thus, Islamic education can continue to contribute to the progress of humanity within a broader framework, namely as a social and moral force capable of overcoming various challenges in this modern era (Khairunnisa et al., 2025).

4. CONCLUSION

Based on a comparative analysis of Syed Muhammad Naquib al-Attas and Ismail Raji al-Faruqi, this study concludes that the crisis of contemporary Islamic education originates from deep epistemological problems, particularly the dominance of the Western secular paradigm that separates knowledge from value and perpetuates the dichotomy between religious and modern sciences. Both scholars agree that the problem is not merely technical-pedagogical, but fundamentally rooted in misunderstandings of the nature of knowledge, humanity, and educational goals within the framework of monotheism. Al-Attas emphasizes the conceptual purification of knowledge through *adab* and the purification of meaning (*tashfiyah al-ma'na*), aiming to form civilized individuals (*insan adib*) who internalize metaphysical, ethical, and intellectual values integrally. Education, in his view, is a process of holistic moral and spiritual formation. Meanwhile, al-Faruqi proposes a more operational and socially transformative approach, focusing on reconstructing modern science through the integration of revelation and rationality within monotheism. His educational goal extends beyond personal piety toward producing social actors committed to justice, benefit, and ethical responsibility. Although differing methodologically, their perspectives are complementary. Their synthesis yields an integrative Islamic education paradigm that combines epistemological purification, ethical orientation, and social transformation. This paradigm highlights the urgency of reformulating curriculum, pedagogy, and institutions based on monotheism, *adab*, and knowledge reconstruction to ensure relevance to modern challenges without losing Islamic identity and spiritual orientation.

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