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The Awareness and Knowledge Levels of Building Information Modeling Among Architecture Students: A Survey-Based Study

Mehmet Ümit METERELLİYOZ*[1]

Abstract

The present study aims to investigate the awareness of Building Information Modeling (BIM) in Turkey from students' perspectives. While numerous studies in the literature have explored BIM awareness in the industry, research specifically focused on students is scarce. Thus, this study aims to contribute a new and current perspective to the existing literature by measuring student awareness based on empirical evidence. By doing so, it intends to provide valuable insights for future research and curriculum development. The research utilized the results of a survey conducted in 2022 involving the participation of 34 fourth-year students in the architecture program. The findings indicate that students have heard about and even utilized the concept of Building Information Modeling, but their knowledge of this technological development needs to be more comprehensive. The survey was designed to assess the students' BIM awareness level to explore their understanding and proficiency in using BIM. The results revealed that students need to learn more about the technological elements and components that constitute BIM. This limitation hampers their potential to utilize BIM in practice effectively. The outcomes of this study underscore the necessity for architecture education programs to adopt a more comprehensive approach to BIM. Developing educational and informational strategies that enhance students' knowledge of BIM is imperative. The findings of this study serve as a valuable resource for increasing BIM awareness in architectural education and facilitating students' adaptation to this technology.

Keywords: Building information modeling (BIM), awareness, architectural education, technology-enabled education.

1. INTRODUCTION

Building Information Modeling (BIM) technology is rapidly gaining popularity in the construction industry worldwide. BIM is a process that enhances efficiency, collaboration, and information sharing throughout all stages of construction projects. Its integration across disciplines, from design to construction and operation, drives significant transformations in the industry [1].

BIM is a technology that generates and manages various construction-related information throughout the entire lifecycle of a building, from initial design to demolition. Unlike traditional CAD technology, BIM offers a broader and more efficient approach throughout the building lifecycle [2].

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Recognizing the limitations of existing CAD technology, countries, particularly the United States, are embracing BIM and acknowledging its potential to bring about a paradigm shift similar to what CAD initially introduced [3].

Adopting and effectively utilizing BIM require substantial changes in the traditional construction process [4]. Thus, providing BIM education to both students and practitioners is crucial. BIM implementation necessitates significant improvements in design accuracy and detail. Interoperability among BIM software is also vital for stakeholder collaboration [5]. Various data exchanges, such as material information and environmental analyses, should occur through a BIM model among participants [6]. Therefore, comprehensive BIM education is necessary to fully leverage this technology's benefits across all stakeholders.

Universities play a vital role in educating future engineers, architects, and professionals in related disciplines. Teaching BIM to students and supporting their learning process is crucial. Universities should organize diverse educational programs and activities to raise students' awareness of BIM and its potential and applications.

Both globally and in Turkey, numerous universities have developed and implemented BIM education curricula [7-9]. BIM education perspectives vary from incorporating BIM software applications into existing CAD courses to designing specialized curricula focused solely on BIM [10]. In Turkey, many leading universities are incorporating theoretical and practical BIM courses into their undergraduate and graduate curricula. Studies have also been conducted on the goals and strategies of BIM education in universities [11].

The study aims to investigate the awareness of BIM from the student perspective in Turkey. Despite numerous studies focusing on BIM awareness in the construction industry in the existing literature, the number of studies explicitly conducted with students is relatively limited, indicating that BIM in architectural education remains an area to be fully explored in terms of students' awareness. Therefore, the study sets out to provide a new and updated perspective on the literature and to measure student awareness in an evidence-based manner.

This article presents the findings of a survey study conducted to examine the impact of BIM awareness on university students. The survey assessed students' knowledge, perceptions, and attitudes toward BIM.

The main objective of this study is to understand students' awareness of BIM and assess their knowledge levels. Additionally, based on the survey results, the study aims to examine students' perceptions and attitudes toward BIM, provide recommendations for BIM education, and contribute to future research in the field.

Although numerous studies have been conducted on BIM awareness and acceptance among professionals in the construction sector, limited research has focused explicitly on students' awareness [12-14]. This lack of awareness directly affects students and creates a learning barrier. Therefore, evaluating BIM education requires measuring BIM awareness and acceptance among students.

Kugbeadjor et al. conducted a study on the BIM awareness and literacy of postgraduate students at universities in the West Midlands region of the United Kingdom. The findings revealed that although the students had heard of BIM, they needed to familiarize themselves with BIM concepts. Additionally, they expressed that their courses needed to provide them with the necessary knowledge and skills, leaving them unprepared to work in a BIM-enabled environment. According to Kugbeadjor et al., there is a need to provide more BIM education and training to university students to meet the industry's

demands. They concluded that this should be done using appropriate methods, tools, and pedagogies [15].

Ahn and Kim conducted a seminal study on the awareness and acceptance of BIM among architecture students in Asia. The study generally found that students had a certain level of awareness of BIM but needed more familiarity with IFC, another key concept related to BIM. The study also revealed that students' BIM awareness was influenced by the classrooms they were in and the countries they came from. According to Ahn and Kim, higher-graders had a higher potential for being aware of BIM. Similarly, students from countries that have integrated BIM into the construction sector showed a higher level of awareness.

Consistent with previous studies, researchers emphasized the need for more planned and effective educational processes to prepare students for BIM in their professional careers [16]. Furthermore, in their highly cited article, Abdirad and Dossick stated that while the use of BIM in architectural education has increased, there is still a need for further education and resources in this regard. The study also demonstrated that students who receive BIM education are significantly more likely to be employed in architecture after graduation.

Mamter et al. researched BIM awareness among students in higher education institutions in Malaysia. The study found that civil engineering and architecture students were highly aware of BIM. Overall, the research indicated an increasing awareness of BIM among students in higher education institutions in Malaysia. However, it also highlighted the need for further BIM education and training to fully prepare students for BIM-integrated professional firms and enterprises [17].

Maina's study measured the levels of CAD and BIM awareness and proficiency among architecture students in Nigeria. The research revealed that most participating students were familiar with CAD (92%) and BIM (87%) technologies. However, their proficiency levels varied in these technologies. Additionally, the students recognized BIM as an essential and effective tool in their projects, although their proficiency in using BIM for 4D-7D modeling was significantly lower [18].

Rosli et al. conducted a study to investigate the perceptions of architecture students in Malaysia regarding using BIM software. The results indicated that despite the increasing BIM awareness in Malaysia's AEC industry, the BIM awareness level among students still needed to be at the desired level. However, architecture students had heard of BIM and recognized its benefits. This suggests that integrating BIM into the curriculum or offering it as a separate course would receive positive engagement from students [19].

While education significantly contributes to adopting BIM, numerous institutions, particularly those in higher education, hesitate to invest in BIM education [20]. Notably, the need for adequate education and training within the construction sector stands out as a prominent obstacle to the widespread integration of BIM [21-22]. A mounting and pressing demand exists for higher education establishments to furnish students with specialized training that aligns with the present requisites of the industry [23-24].

In line with this perspective, several researchers underscore that Building Information Modeling (BIM) education should be integrated into architecture and engineering curricula [25-26]. Consequently, universities globally have initiated the inclusion of BIM in their educational programs. This is achieved through the establishment of seminars, workshops, lectures, and dedicated courses at both the undergraduate and graduate tiers, all aimed at equipping students for the demands of the industry [27].

Indeed, grounded in the existing literature, a pivotal aspect of BIM education is the assessment of students' levels of awareness. Subsequently, this assessment should inform the development of curricula and educational programs tailored to these individual levels. A profound comprehension of the potential advantages and application domains of BIM technology among students will significantly enhance their readiness to address the forthcoming requisites of the Architecture, Engineering, and Construction (AEC) sector. This heightened awareness has the potential to augment their skills and competencies, thereby rendering them more adaptable to the expeditiously evolving landscape of the industry and its technological advancements.

As the integration of BIM into the AEC industry intensifies, students who have received a robust BIM education will inevitably gain a competitive advantage in the job market. This advantage will enable them to make substantial contributions to the growth and innovation of the industry. Accordingly, higher education institutions should deploy efficacious educational resources and interactive pedagogical approaches to bolster students' awareness regarding BIM. This strategy will foster increased engagement and active participation among students.

Furthermore, considering the rapid evolution of BIM technology, it remains imperative to consistently update educational programs and align them with the latest industry developments. Students ought to receive practical training that encompasses not only the fundamental principles of BIM but also serves to enhance their application skills and collaborative capacities.

BIM is poised to become a foundational element in forthcoming construction and design projects. Consequently, higher education institutions must heighten their endeavors to augment awareness about BIM. Furnishing students with a comprehensive understanding of the potential benefits and significance of BIM technology within the industry will invariably render future building professionals more adept and competitive. This, in turn, will empower them to make meaningful contributions to the Architecture, Engineering, and Construction (AEC) sector.

2. METHOD

This study aims to evaluate the level of BIM awareness among architecture students at Bolu Abant İzzet Baysal University, a higher education institution in Turkey. The research seeks to gather information regarding BIM awareness among students in higher education institutions, utilizing primarily quantitative research methods. Surveys were employed as the primary data collection instrument in this study. The survey participants consisted of 4th-year students at Bolu Abant İzzet Baysal University (BAİBÜ) in 2022, with 34 students participating. Consistent with previous literature, this study examines the awareness and acceptance of BIM by employing a survey as the research method [15-16].

As a component of the study, students received a written questionnaire and were solicited for feedback. The entire cohort of 34 participating students submitted their responses. After the students completed the questionnaires, the acquired data underwent analysis employing statistical techniques encompassing frequency distributions, means, standard deviations, and correlations, utilizing the Excel™ software. Elaborate details of the outcomes are expounded upon in the ensuing section. The findings have yielded invaluable insights into the students' viewpoints, inclinations, and encounters pertinent to education. These revelations have substantiated the research objectives and rendered pertinent contributions to the existing body of literature.

The survey comprised ten questions, utilizing a 5-point Likert scale for ranking and enabling multiple-choice responses. The questions aimed to assess students' opinions,

expectations, and knowledge levels on BIM. Various topics were covered in the questionnaire, including students' utilization and familiarity with BIM, awareness of the fundamental technologies underlying BIM, practical advantages of BIM implementation, BIM usage, and user accessibility.

The assessment of students' comprehension, attitudes, and behaviors was conducted from a multidimensional perspective, including questions about BIM and its subcomponents. Additionally, multiple-choice and open-ended questions were employed to gauge students' overall knowledge levels and attitudes. Descriptive statistics and graphs were employed to analyze participants' awareness and acceptance of BIM, aiming to identify general characteristics.

3. RESULTS

The survey participants consisted of fourth-year architecture students. As depicted in Figure 1, a significant proportion of the students exhibited familiarity with various design software, including AutoCAD, Photoshop, and SketchUp.

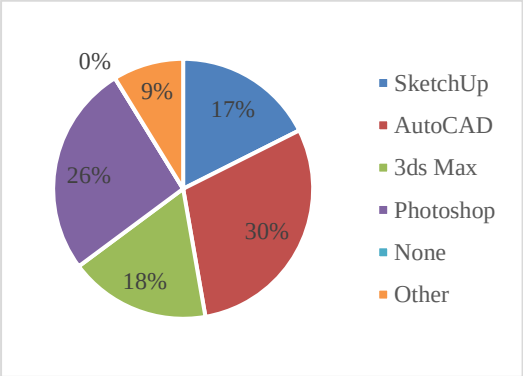

Figure 1 Design software usage ratios

The students were surveyed regarding their awareness of Building Information Modeling (BIM), and their responses were collected using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Out of the total respondents, 79% of the students (with a mean score of 3.67) stated that they had heard of BIM (Figure 2). However, the percentage decreases to 52.94% (with a mean score of 3.29) when answering the question, "Do you have knowledge about BIM?" It was found that approximately half of the students were aware of the term BIM but did not possess a comprehensive understanding of its concept (Figure 3).

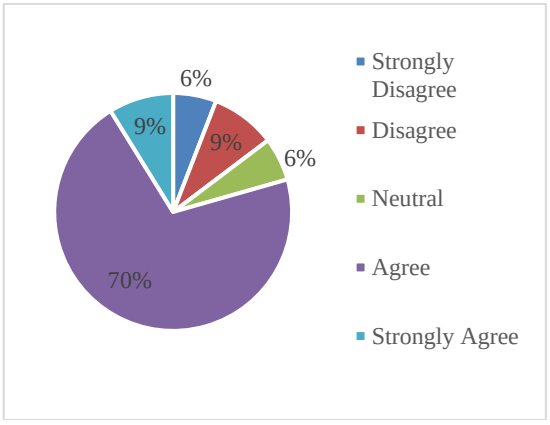

Figure 2 Ratios of students' hearing about BIM

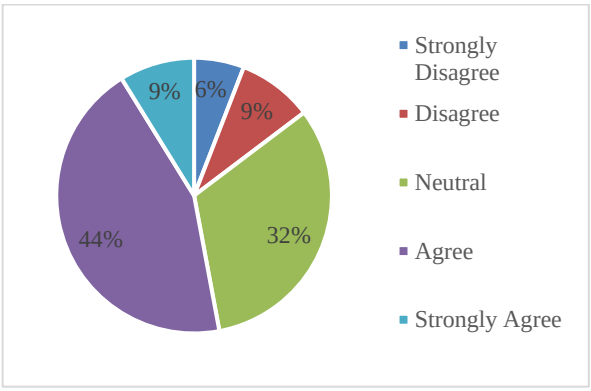

Figure 3 Answers to the question “Do you know BIM?"

Regarding their exposure to BIM education, 47% of the participants reported not having received any BIM education. Conversely, 53% of the respondents stated they had received some form of BIM-related education. Regarding the sources of this education, respondents identified university courses (20%), external courses and training (21%), and online resources (12%) (Figure 4). Notably, 94% of survey participants believed that universities should offer BIM education, highlighting the perceived significance of universities in providing BIM education as acknowledged by the students.

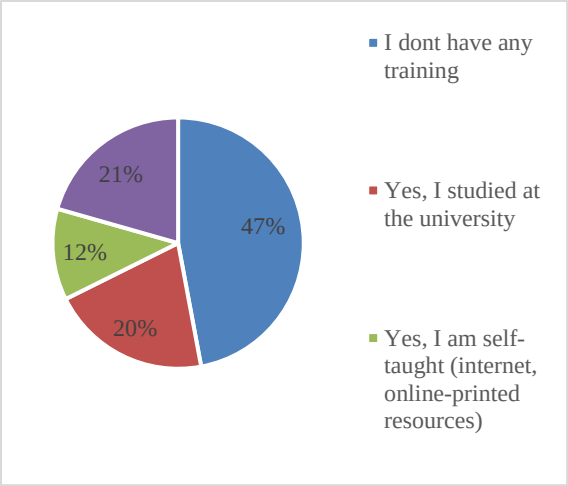

Figure 4 BIM education and utilized resources

Similar trends are evident in students' viewpoints regarding the impact of Building Information Modeling (BIM) on their professional trajectories and academic endeavors. The survey results indicate that most participants (85%, with a mean score of 3.88) believe BIM and its associated technologies possess considerable potential to shape their student and professional careers (Figure 5). This finding underscores the perception among nearly all students that, despite lacking a comprehensive definition of BIM, it represents a momentous technological advancement and is regarded as a significant progression in both their academic pursuits and professional pathways.

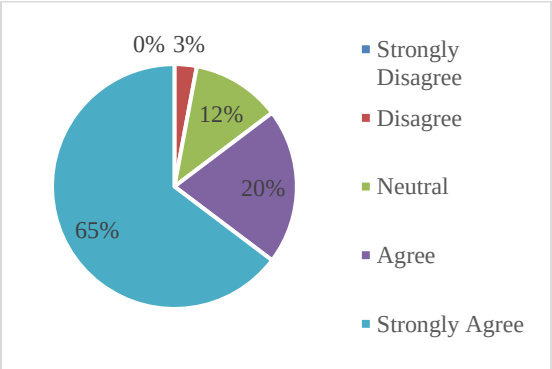

Figure 5 Participants' expectations about the impact of BIM on academic and professional life

Participants were surveyed regarding their utilization of Building Information Modeling (BIM) in various domains. Corresponding to the preceding responses, approximately half of the participants indicated a lack of engagement with BIM. Among those who reported using BIM, the highest adoption ratio was noted in the realm of architectural design (27%), closely trailed by its application in presentations (15%) (Figure 6). Nonetheless, the students employing BIM software have yet to harness its capabilities in architectural quantity takeoff.

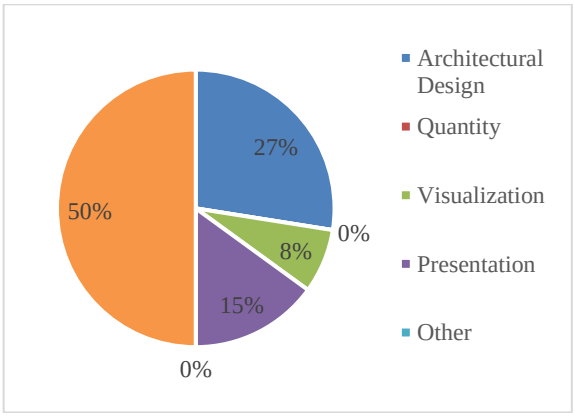

Figure 6 BIM usage areas

One additional inquiry in the survey pertains to the BIM software market. Among the survey respondents who employ BIM in their projects, 42% utilize Revit, whereas 8% employ ArchiCAD. None of the participants indicated using software such as Allplan, Vectorworks, BricsCAD, or Bentley MicroStation (refer to Figure 7).

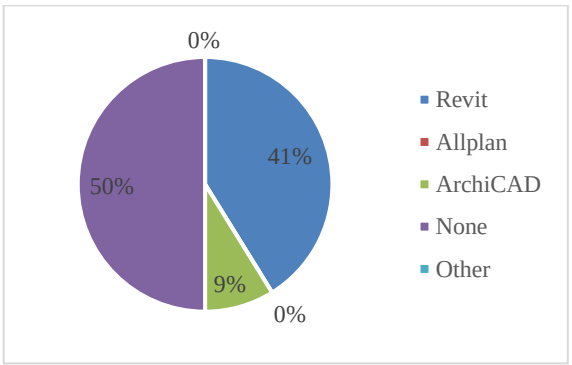

Figure 7 BIM software usage ratios

The study's findings indicate that while most students possess some background knowledge about Building Information Modeling (BIM), the fact that nearly half of them have never utilized BIM software suggests that the current system of BIM education lacks sufficient effectiveness and readily available educational resources.

In addition to assessing BIM awareness, the study also inquired about the students' familiarity with related technologies such as nD modeling and interoperability. In contrast to BIM awareness, a staggering 90% of participants reported never having heard of nD modeling, with a mean score of 2.00 (Fig. 8). Similarly, the percentage of students unfamiliar with the concept of interoperability stood at 79%, with a mean score of 2.65 (Fig. 9).

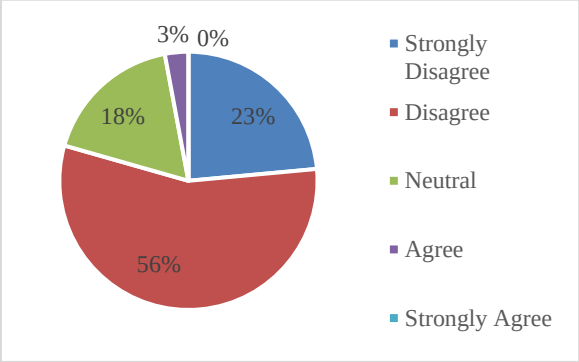

Figure 8 nD modeling awareness

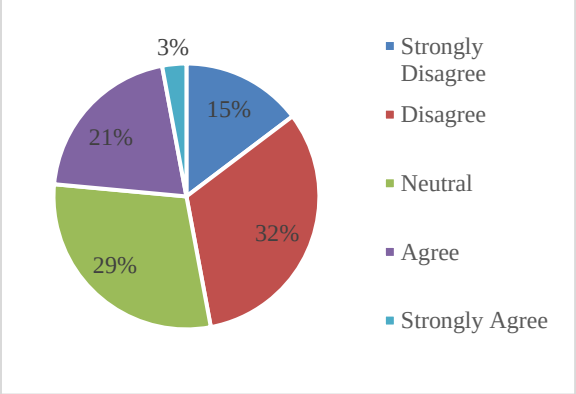

Figure 9 Interoperability awareness

Most students need help understanding Building Information Modeling (BIM), including crucial elements like nD modeling and interoperability. This limited knowledge implies that their comprehension of BIM could be deeper and more open. The lack of familiarity with BIM and its associated technologies suggests that students primarily employ BIM solely for visualization. As a result, it becomes evident that students need more awareness of other integral aspects inherent in BIM, such as quantity takeoff, structural and environmental analysis, nD modeling, building lifecycle management, and more. To break this cycle and enhance BIM education, it would be advantageous to integrate BIM and its related technologies and the theoretical foundations of BIM into the university curriculum.

4. CONCLUSION

The present study aims to present the findings of a survey conducted among architecture students, specifically focusing on their awareness of Building Information Modeling (BIM). From a general perspective, architecture students predominantly rely on traditional software, such as AutoCAD, for design purposes rather than utilizing BIM software. Furthermore, approximately half of the students surveyed have yet to gain experience with BIM education or software. However, through in-depth analysis and evaluation, it has been determined that there is a significant demand for BIM education.

While BIM awareness tends to generate increased interest among students, it is essential to note that this does not necessarily extend to BIM-related technologies. Therefore, BIM education should be broader than just software training. Students require comprehensive education to understand the applications and benefits of various BIM-related fields.

This research highlights the need for universities to contribute more to BIM education. Developing a well-balanced BIM curriculum for undergraduate and graduate students is recommended. Instead of superficially focusing on the concept of BIM, attention should be given to its fundamental principles, applications, and underlying concepts. To achieve this, the educational curriculum can incorporate comprehensive course content, practical exercises, workshops, and collaborations with industry professionals. Additionally, providing supportive resources such as online materials, educational videos, and interactive learning materials can help address students' knowledge gaps in BIM.

The results of the study offer significant recommendations for enhancing BIM awareness in architectural education. First and foremost, educational and informative strategies should be developed to give students fundamental knowledge about BIM. Students need to be equipped with information encompassing the definition, historical evolution, developmental trajectory, purposes, advantages, disadvantages, application areas, and prospects of BIM.

Secondly, practical exercises should be executed to equip students with proficient BIM skills. Students ought to acquire a comprehensive understanding of BIM software, tools, standards, and protocols. Additionally, they should be afforded opportunities to apply and experience these tools within authentic projects. Thirdly, concrete real-life examples should be presented to students to exemplify BIM's significance and profound impact within the industry. Students must grasp both BIM's current and future roles in the construction and architecture sectors while also gaining insights into the associated opportunities and challenges.

Considering that BIM is rapidly being adopted in the construction industry, the findings of this study can provide insights for future educational and research endeavors. Increasing awareness and educational efforts related to BIM can equip students with enhanced skills for their professional careers and help meet the industry's demands.

The study has yielded significant findings in terms of examining BIM awareness from the student perspective in Turkey. However, there are noteworthy points that require attention for future research. Firstly, this study is confined to 4th-year architecture students exclusively. Subsequent research should employ a more extensive sample, encompassing students from diverse construction and architectural disciplines. An enlarged sample would provide a more comprehensive understanding of the influence of students at varying educational levels on BIM awareness.

Secondly, this study exclusively concentrated on gauging student awareness. However, it omitted an evaluation of students' proficiency and competencies regarding BIM technology. Future research could execute a more all-encompassing analysis, assessing students' technical knowledge and skills pertaining to BIM. Moreover, practical assessment methods could be employed to grasp the effects of BIM education programs in enhancing students' skill development in this domain.

Thirdly, although this study centered on BIM awareness in Turkey, it should have addressed a comprehensive cross-country comparison of BIM awareness among students. Future research should explore the distinctions and commonalities in students' BIM awareness across different nations. This initiative will facilitate an understanding international intersection between education and industry, thus fostering the formulation of more effective global-scale educational strategies for BIM.

Finally, this study solely addressed the student dimension. Subsequent research could embrace a multi-stakeholder and layered research approach, encompassing the perspectives of educators, industry representatives, and BIM technology users. By doing so, we can attain a more profound comprehension of the inadequacies in BIM awareness and contribute to formulating more effective educational and implementation strategies in this realm. These limitations and the suggestions for future research will aid us in evaluating the outcomes of this study within a broader context, and in identifying potential contributions that can be made in the field to enhance BIM awareness.

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The Declaration of Conflict of Interest/ Common Interest
The author declares no conflict of interest or common interest.

The Declaration of Ethics Committee Approval
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The Declaration of Research and Publication Ethics
The authors of the paper declare that they comply with the scientific, ethical and quotation rules of SAUJS in all processes of the paper and that they do not make any falsification on the data collected. In addition, they declare that Sakarya University Journal of Science and its editorial board have no responsibility for any ethical violations that may be encountered, and that this study has not been evaluated in any academic publication environment other than Sakarya University Journal of Science.

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