THE CYPRUS JOURNAL OF SCIENCES

PUBLISHED BY AMERICAN COLLEGE

VOL. 23 / 2025

The Cyprus Journal of Sciences

The e-Journal of American College

The Cyprus Journal of Sciences
The e-Journal of American College
2025 Vol. 23

CONTENTS

REFORMING THE EU'S COMMON FOREIGN AND SECURITY POLICY: FROM UNANIMITY TO QUALIFIED MAJORITY VOTING

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ABSTRACT

The European Union's Common Foreign and Security Policy (CFSP) is central to its external action. However, its dependence on unanimity in decision-making limits the EU's ability to respond swiftly and consistently to international crises. This paper analyzes the structural, legal, and political obstacles to reforming the CFSP, particularly a potential shift from unanimity to Qualified Majority Voting (QMV). Drawing on literature reviews, institutional analysis, and case studies—such as Ukraine-Russia relations, the Libyan crisis, and the Eastern Mediterranean disputes—the paper identifies the main opportunities and risks of introducing QMV. QMV offers the potential to improve strategic autonomy, speed of crisis response, and the EU's global credibility. At the same time, it presents challenges related to national sovereignty, questions of democratic legitimacy, and the possibility of political backlash. Ultimately, the paper argues for a gradual, sectoral approach to reform, with safeguards such as opt-in/opt-out provisions and emergency brakes, to strengthen the EU's ability to act collectively in foreign and security matters without overriding Member State authority.

Keywords: *European Union; Common Foreign and Security Policy; Qualified Majority Voting; Unanimity; Strategic Autonomy; EU Integration.*

1. INTRODUCTION

The EU has long struggled to balance national sovereignty with supranational decision-making in foreign and security policy. The Common Foreign and Security Policy (CFSP), established under the Maastricht Treaty (1992) and detailed in the Amsterdam and Lisbon Treaties, is where EU Member States seek unified global action while keeping control over national security. Unlike internal market regulations, which use Qualified Majority Voting (QMV) in the Council, the CFSP mostly relies on unanimity to respect national sensitivities.

Unanimity ensures no Member State is forced into policies against its core interests, but it also hinders decisive EU action in fast-changing international situations. The Lisbon Treaty introduced "constructive abstention" to reduce deadlocks and boosted the High Representative's role to improve coherence. Still, unanimity leads to paralysis during crises, undermining EU credibility as a global actor.

The discussion about changing CFSP decision-making from unanimity to QMV raises fundamental questions: Should the EU prioritize collective action or the protection of national sovereignty and democratic legitimacy? Supporters of QMV assert that it will deliver greater strategic autonomy, faster crisis response, and a more effective European voice on the world stage. Critics argue that shifting to QMV could diminish Member State

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control over security and foreign policy, increase the risk of alienating smaller states, and provoke domestic resistance.

This paper examines whether reforming CFSP to include QMV is both feasible and desirable. It does so by reviewing the historical, legal, and geopolitical context and analyzing detailed case studies: the EU's responses to the Ukraine-Russia conflict, the Libyan crisis, and tensions in the Eastern Mediterranean. The goal is to clarify the main structural challenges and opportunities in shifting from unanimity to QMV in the CFSP context.

2. LITERATURE REVIEW

The scholarly discourse on CFSP reform reflects divergent theoretical perspectives on European integration. Neo-functionalists emphasize the potential for spillover effects, where incremental cooperation in one policy area fosters deeper integration in others (Haas, 1964; Schmitter, 2005). From this standpoint, introducing QMV in CFSP could catalyze political convergence, enabling the EU to act more cohesively on the international stage. Intergovernmentalist scholars, by contrast, underscore the primacy of national interests and the enduring influence of powerful Member States in shaping EU foreign policy (Moravcsik, 1998). In their view, unanimity safeguards essential sovereignty, and any shift toward QMV must navigate entrenched resistance.

Recent studies focus on the operational constraints imposed by unanimity. Smith (2019) highlights that decision-making delays hinder timely responses to crises, while Tocci (2020) argues that the CFSP's limited effectiveness diminishes the EU's global credibility, particularly compared to more centralized actors such as the United States. The European Council on Foreign Relations and Bruegel policy analyses echo these findings, emphasizing that the EU's inability to adopt coherent positions in sanctions regimes or peacekeeping missions undermines its strategic autonomy (ECFR, 2021; Bruegel, 2022).

Constructive abstention, a Lisbon Treaty innovation, allows a Member State to abstain without blocking a decision. Scholars such as Howorth (2014) argue that this mechanism partially mitigates the unanimity constraint but cannot resolve conflicts of fundamental national interest. The literature suggests that incremental reforms, including sectoral QMV or opt-in/opt-out mechanisms, may balance efficiency with sovereignty preservation. Nonetheless, there is limited empirical evidence on how such reforms would operate in practice, particularly in high-stakes security contexts.

Legal Framework:

The CFSP is governed primarily by the Treaty on European Union (TEU), notably Articles 21–46. Article 31 establishes that Council decisions in the CFSP are to be taken by unanimity, except where the Treaties provide otherwise. The Lisbon Treaty (2009) introduced the High Representative of the Union for Foreign Affairs and Security Policy (HR/VP), combining the roles of the former High Representative and European Commissioner for External Relations, to enhance coherence and visibility of EU foreign

policy.

Procedural Innovations:

The Lisbon Treaty introduced the constructive abstention mechanism (Art. 31(2) TEU), permitting a Member State to abstain without blocking adoption. While innovative, it is limited to decisions where abstention does not impede the implementation of the EU's common position. Additionally, the Treaty includes the "passerelle clause" (Art. 31(3) TEU), which allows the Council to shift certain CFSP decisions from unanimity to QMV with the consent of the European Parliament. However, this clause has never been invoked, largely due to political sensitivity and national reluctance.

Institutional Dynamics:

The European External Action Service (EEAS), led by the HR/VP, aims to streamline policy formulation, diplomatic representation, and operational coordination. Nevertheless, the EEAS's effectiveness is constrained by Member States' divergent interests, the need for unanimity in decision-making, and the absence of robust enforcement mechanisms. Hence, while institutional structures exist to support reform, the procedural rigidity of unanimity remains a central obstacle.

Case Studies:

Ukraine and Russia (2014 - 2022)

The EU's response to the annexation of Crimea and subsequent conflicts in Eastern Ukraine illustrates the limits of unanimity. Coordinated sanctions required extensive negotiation, with some Member States advocating for a cautious approach due to economic and energy dependencies. The unanimity requirement prolonged the adoption of measures, highlighting the trade-off between national sensitivities and timely international action. Scholars such as Emerson et al. (2017) argue that QMV could have accelerated decision-making while maintaining strategic coherence, albeit at the cost of overriding certain national preferences. In February 2022, President of Russia Vladimir recognised the Russian-controlled areas of southeast Ukraine as independent states. In the follow-up of his decision, Putin Vladimir Putin ordered his military to enter these areas as "peacekeeping forces".

This demonstration of power on behalf of Russia on Ukraine was not the first one, considering the annexation of the Crimea peninsula a few years back. The well-known differences between Russia and the EU escalated, but they were always present in a peculiar form of what is normative.

Russian policies clash with Europe's goals, visions, and values in multiple areas: from Europe's eastern neighbourhood to the Middle East, from global great-power relationships to domestic arrangements. The EU's motivation in its relations with Russia is primarily but

not exclusively driven by strategic interests.

Eastern Mediterranean: Cyprus/Greece–Turkey Disputes

Tensions in the Eastern Mediterranean over maritime boundaries and energy resources illustrate how unanimity allows a single Member State to veto collective action, thereby complicating the EU's responses to regional disputes. The inability to adopt unified sanctions or diplomatic measures weakens the EU's bargaining position vis-à-vis external actors. Proposals for sectoral QMV in areas like sanctions demonstrate a potential compromise between efficiency and national sovereignty.

Risks and Opportunities of QMV:

- **Opportunities**

    1. **Enhanced Strategic Autonomy:** QMV could enable the EU to adopt positions rapidly, reinforcing its role as a credible international actor. The European Parliament has repeatedly expressed its support for greater use of QMV in its annual resolutions on the implementation of the CFSP, based on a report by its Committee on Foreign Affairs (AFET), and has long urged the Member States to use QMV for decisions in areas of CFSP that do not have military or defence implications and to make full use of passerelle clauses under Article 31(3) of the Treaty on European Union (TEU).
    2. **Crisis Responsiveness:** Faster decision-making could improve humanitarian, security, and economic responses to global crises.
    3. **Incremental Integration:** Sectoral QMV may serve as a catalyst for deeper integration, fostering convergence in foreign policy preferences.

- **Risks**

    1. **Sovereignty Concerns:** Smaller Member States may perceive QMV as a threat to national control over security and foreign policy.
    2. **Domestic Backlash:** Citizens may question the democratic legitimacy of policies imposed despite national opposition.
    3. **Policy Fragmentation:** Allowing opt-outs and constructive abstention may reduce the risks of imposing unwanted decisions, but these tools cannot resolve core disagreements over national interests.

Mitigation Mechanisms:

Proposals include an "emergency brake" allowing temporary suspension of QMV in sensitive matters, opt-in/opt-out frameworks, and enhanced consultation with national parliaments to preserve legitimacy. These mechanisms could balance efficiency gains with

political acceptability.

3. CONCLUSION AND POLICY RECOMMENDATIONS

Over the past decade, qualified majority voting, which requires the approval of 55% of member states representing at least 65% of the EU population, evolved to be the standard voting rule in the Council, replacing unanimity in an increasing number of domains, from humanitarian aid and external border controls to single market rules or climate targets. But member states are reluctant to give away sovereignty when it comes to deciding on sensitive issues such as foreign affairs and security.

The debate over reforming the CFSP reflects a broader tension in European integration: balancing national sovereignty with collective efficacy. Unanimity, while protective of Member State interests, undermines the EU's ability to act decisively in a complex international environment. Constructive abstention and institutional reforms under the Lisbon Treaty have provided incremental improvements, but they remain insufficient to fully address decision-making bottlenecks.

Introducing QMV, particularly in specific sectors such as sanctions, peacekeeping, or crisis response, offers a feasible path toward enhancing the EU's strategic autonomy and global credibility. To mitigate political resistance, reforms should be gradual and accompanied by safeguards such as an emergency brake and opt-in/opt-out options. Additionally, greater transparency, parliamentary involvement, and robust public communication could enhance the legitimacy of such reforms.

Ultimately, CFSP reform represents a crucial test of the EU's capacity to act as a unified global actor while respecting the diversity of its Member States. By carefully calibrating the shift from unanimity to QMV, the Union can strengthen both its internal cohesion and its external effectiveness, ensuring that it is prepared to meet the security and diplomatic challenges of the 21st century.

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STUDENTS' ATTITUDES IN SCIENCE EDUCATION: EVIDENCE FROM CYPRIOT PRIMARY SCHOOLS

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ABSTRACT

Students' attitudes towards school science are considered by researchers as a key part of improving students' science attainment and their future involvement with science. Research studies conducted in Cyprus highlight the association between positive attitudes towards school science and Cypriot students' science achievement. However, studies that provide insights into what Cypriot students' attitudes towards school science are, have been sparse. To study this, the present study, employed mixed methods, involving the collection of 161 questionnaires and 5 group interviews with 18 students. The findings suggest that year 6 (final year of primary school) students' attitudes towards school science are overall positive. There were no significant differences identified between the attitudes of girls and boys towards school science. Teacher and enjoyment of experiments were found to be key factors affecting students' attitudes towards school science. The study has resulted in a validated instrument that can be used to collect data regarding students' attitudes towards school science in Cyprus and other countries.

Keywords: *Attitudes; Science; School; Primary School; Attainment; Cypriot Students; Gender; Teacher; Science Enjoyment; Questionnaires; Interviews.*

1. INTRODUCTION

The attainment and participation of students in science related studies and later in science related careers has received increasing attention in developed countries over the last two decades (Hill et al., 2010; Tytler and Osborne, 2012; Bottia et al., 2015; Cooper et al., 2020) with governments around the world placing science at the heart of their country's future prosperity (Jerrim, 2021). The growing number of studies conducted in the last two decades report a relationship between the low participation in science after the period of compulsory school science and the poor attitudes of students towards school science (Collette Murphy and Beggs, 2001; Jenkins et al., 2010; Trowler, 2010; Sammons et al., 2012). According to Linnenbrink-Garcia and Pekrun (2011), attitudes towards school science is potentially one of the factors that may impact students' course and career choices. Research conducted in the last four decades also indicates a link between students' attitudes towards school science and the achievement of students in science (Hough and Piper, 1982; OECD, 2016; Mourshed et al., 2017; Liou, 2020; Jerrim, 2021).

The ongoing research indicates that students' attitudes towards school science and students' science career aspirations can depend on a range of factors including gender (Barmby, Per M. Kind, et al., 2008; DeWitt and Archer, 2015; Yamtinah et al., 2017), ethnic background (DeWitt and Archer, 2015) , teaching style, type of school, background of parents and social class (Dewitt et al., 2014; Mujtaba et al., 2018) and that individual

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students' attitudes towards school science may become less positive at different times throughout their school years. (Breakwell and Beardsell, 1992; Galton, 2002; Osborne et al., 2003; Braund and Driver, 2005; Logan and Skamp, 2008; Tytler et al., 2008).

The results of the most recent (at the time of the study) PISA (Program for International Student Assessment, 2015 and 2018) as well as TIMSS (Trends in International Mathematics and Science Study 2015 and 2019) are quite concerning regarding the attainment of Cypriot students in science (University of Cyprus, 2016). PISA (2015) results are characterised as 'appalling' and disappointing (Cyprus Mail, 2016; University of Cyprus, 2016) for Cyprus, showing that Cyprus has the worst performing students in the EU in science, maths and literacy. Given this association, this study aims to look into Cypriot students' attitudes towards school science.

More specifically, this study, is an investigation of year 6 (final year of primary school) Cypriot students' attitudes towards school science. Previous studies, using secondary data and analysis from TIMSS have looked at Cypriot students' attitudes within the broader context of their attitudes to science and the association of attitudes and students' attainment (such as Papanastasiou and Zembylas, 2002; Papanastasiou, 2002; Mettas, 2006). The purpose of this research, in contrast to these studies, is to collect primary data, specifically measuring the attitudes of year 6 students towards school science; both their attitudes towards their year 6 science and their attitudes towards and expectations of year 7 science. It is also exploring the factors that affect the formation of students' attitudes towards school science.

2. LITERATURE REVIEW

2.1 Definition of the term 'attitudes'

Researchers, studying attitudes towards science (e.g., Germann, 1988; Francis and Greer, 1999; Osborne et al., 2003; Aydeniz and Kotowski, 2014) have identified a challenge in what attitude means. Kind et al. (2007), underline that 'there seem to be many concepts that relate to attitudes that may or may not be included in their definition; for example, feelings, motivation, enjoyment, affects, self-esteem, and so forth' (p.872).

A number of authors (Ostrom, 1969; Hollander, 1976; Breckler, 1984; Hogg and Vaughan, 2005; Reid, 2006) define attitudes as a multidimensional concept consisting of the affective, the cognitive and the behavioural domain. The affective domain, involves the feelings about an attitude object (e.g. school science), it is 'the like or dislike component' (Reid, 2006, p.4). The cognitive dimension refers to the knowledge, the beliefs and ideas one holds about an attitude object. Finally, the behavioural component is defined as the actions that one decides to take as a result of their affective and cognitive attitude towards the attitude object.

While attitudes in general are considered as a multidimensional concept by a number of researchers, as discussed above, it appears that a major part of the research around attitudes towards science have been focusing only on the affective attitudes of students (Klopfer, 1971; Gardner, 1975; German, 1988). However, as attitudes is considered by a

number of authors as a multi-dimensional concept, as discussed above, we thought that it would be important to consider aspects of all the three attitudinal domains (affective, cognitive, behavioural) in this study.

For the purpose of the present study students' attitudes towards school science are defined as '***the feelings, beliefs and ideas of students towards school science, based on the impact of influence objects and the behaviour induced as a result of these feelings, beliefs and ideas.'*** The term 'influence objects' refers to any situation, experience, object or individual whose actions may influence students' attitudes towards school science.

2.2 Students' attitudes towards school science around the world

Studies in the UK (Galton and Willcocks, 1983; Hargreaves, 2002; Galton, 2002) and around the world (Kahle and Lakes, 1983; Yager and Penick, 1986; Logan and Skamp, 2008; Cermik and Fenli – Aktan, 2020) have reached the conclusion that primary school students have positive attitudes towards school science. DeWitt et al. (2014), argue that the majority of students enjoy school science and that they maintain positive attitudes through secondary school. In an earlier study, Archer et al. (2010) highlight that one of the main factors contributing to the engagement of primary school students to school science is their expectation that school science will offer them the opportunity to do a lot of practical experiments, create explosions and that science will be 'dangerous and exciting' (Archer et al., 2010, p. 621). The science education tracker, a large-scale survey completed by the Department for Education (Hamlyn et al., 2020) also showed that students' attitudes towards school science are positive and are maintained positive as students move from primary to secondary school.

Research by Logan and Skamp (2008) using both qualitative and quantitative data collection from the participant students as well as their peers showed that the majority of students (96%) enjoyed primary school science and 90% were looking forward to study science in secondary school while 78% of the primary school students expressed the idea that they would enjoy secondary school science.

2.3 Factors affecting students' attitudes towards school science

Many of the reviewed papers, show that science teacher plays an important role in the development of students' attitudes towards school science (George, 2000; Papanastasiou, 2002; Frenzel et al., 2009; Bennett, Braund, et al., 2013; Hadzigeorgiou et al., 2019). More specifically, teachers' enjoyment while teaching their topic (Frenzel, 2009), teaching style and teacher personality (Papanastasiou, 2002; Hadzigeorgiou et al., 2019), teacher attitude (Denessen et al., 2015) appear to be very important in the development of positive student attitudes. Research also points out that teacher feedback, expectations and encouragement influence students' positive attitudes towards science (George, 2000; Stake and Mares, 2001). Finally, teacher specialism was also found to impact students' attitudes and post-compulsory participation in science (Reid and Skryabina, 2002; Cerini et al., 2004; Bennett, Lubben, et al., 2013; Bennett, Braund, et al., 2013).

Hands on activities and practical work are not always considered to have a higher

impact in developing science skills and knowledge as compared to content -driven or textbook based science learning (Pine et al., 2006) but they are considered as a factor sustaining students' engagement with science (Foley and Mcphee, 2008, Mansell, 2011). In Logan and Skamp (2008), students expressed the idea that in primary school they had the opportunity to participate in a lot of 'fun' activities', 'hands on' experiences and 'practical investigations' (p.14). The students had scored a high science interest score. Osborne et al. (1998) claim that practical work has an essential role in shaping students' attitudes towards school science while research by Sharpe (2015) and Mansell (2011) shows that students positive attitudes towards secondary school science are formed during primary school as students are looking forward to moving to secondary school and to performing 'interesting' (Sharpe, 2015, p.29) science experiments. Students in year 6 are looking forward to spend time in the secondary science laboratory (Cleaves, 2005; Braund and Driver, 2005) using more sophisticated equipment and doing 'dangerous' experiments (Jarman, 1993; Griffiths and Jones, 1994).

The literature suggests that another factor that impact students' attitudes towards school science is the perception of science as useful or important for their future career (Jenkins and Nelson, 2005; Osborne and Collins, 2010; Dewitt et al., 2014; Mujtaba et al., 2018). Although a number of students do not find secondary school science as interesting, or they perceive it as less fun or more difficult than other subjects (Ogunkola and Samuel, 2011) they have and maintain their positive attitudes towards the subject as they recognise its importance in their future career aspirations. Bennett et al. (2013), too, concluded that a number of students who appeared to have positive attitudes towards secondary school science began to shape their future career directions in the primary – secondary school interface and they expressed the idea that future employers would value science – related skills. Furthermore, the early secondary school students who participated in the NFER study (Mansell, 2011) and who had generally positive attitudes towards science recognised the value of studying science for accessing University as it was seen as a 'good' (p.26) subject for university entry and as 'opening doors' (p.26) to a wider range of career options.

Another factor influencing students' attitudes towards school science is the impact of significant individuals (such as parents, teachers and peers) and their perceived importance of secondary science (Osborne et al., 1998; Archer et al., 2011; Aschbacher et al., 2014; Hanley et al., 2020). Studies suggest that families play an important role in encouraging students' interest, positive attitudes and decision to follow science careers (Ferry et al., 2000; Gilmartin et al., 2006). Archer et al. (2015) have explained this using the term 'higher science capital' building on the work of the sociologist Bourdieu's concept of capital (Bourdieu, 1986). Some studies have shown that parental effects on science attitude and interest differ by ethnicity (Huang et al., 2000). Peer attitudes towards science (George, 2000) as well as having friends to share science interests with (Stake and Nickens, 2005) are also found to be important factors that affect students' attitude towards school science. Research (Karagiorges 1986; Papanastasiou and Papanastasiou, 2004; Papanastasiou and Zembylas) has shown that Cypriot parents are a great influence on their children's attitudes towards school science and career choices with Papanastasiou and Zembylas (2002) stating that 'Cypriot families tend to favour longer-term advantages that stem from being well

educated (p.471)'. Papanastasiou and Papanastasiou (2004) also researched with Cypriot students and found out that one of the strongest influences towards school science attitudes was that of the students' families and peers. However, other studies, such as the ones conducted by Atwater et al. (1995) and Schibeci (1989) found no impact of the peer group on the attitudes towards school science of individuals.

The impact of gender on students' attitudes towards school science has been the focus of a number of studies in the literature (Weinburgh, 1995; Galton, 2002; Francis and Greer, 2006; Krapp and Prenzel, 2011; Sofiani et al., 2017; DfE, 2019; Reilly et al., 2019; Hamlyn et al., 2020). The results of most research suggest that there continue to be significant gender differences in attitudes and perceptions towards school science, science courses and careers, with boys showing more positive attitudes than girls (Weinburgh, 1995; Gail Jones et al., 2000; Miller et al., 2006; Bennett and Hogarth, 2009; Hampden – Thompson and Bennett, 2011). Bennett and Hogarth (2009) found significant gender differences in the attitudes towards biology, chemistry and particularly physics, with girls showing more positive attitudes towards biology and boys showing more positive attitudes towards physics and, to a lesser extent, chemistry.

Drawing on the literature review, and identifying the gaps in the Cyprus -specific literature, the purpose of this study is threefold: a) to examine what attitudes are held towards school science by primary school students in Cyprus, b) to investigate the factors that impact the formation of these attitudes and c) to identify any differences between the three attitudinal domains (affective, cognitive and behavioural) in students' attitudes towards school science.

3. METHODOLOGY

3.1 Data collection and participants

The study was a cross-sectional study which employed mixed methods for the data collection. Questionnaires were used to get a general idea about what students' attitudes towards school science are in Cyprus and identify any factors that impact these attitudes. Group interviews were used to gain an in-depth understanding about why these attitudes are formed and how different factors affect their formation.

The data for this study, was collected from the students of five different 'typical', mixed, primary schools in Cyprus (three in urban areas and two in rural areas) at the same point in time. By the term 'typical' we mean they have around the average number of students attending and they are comprehensive state schools so private schools, which are different in character (e.g., they follow a different national curriculum) were avoided.

The questionnaire data was collected from 161 questionnaires (which took around 15 minutes to complete) to the year 6 students (age 11-12) of the participant primary schools in the summer term. The response rate was excellent in most schools with most of the parents consenting for their children to participate in the study. The questionnaires were developed using previously validated instruments (Kind, Jones, Barmby, et al., 2007; Sjøberg and Schreiner, 2010; DeWitt et al., 2011). Additional scales or items were developed for the constructs and items of interest for which existing instruments were not

sufficient, drawing on the literature (Galton and Hargreaves, 2002; Osborne et al., 2003; Murphy and Beggs, 2003; Barmby, Per M. Kind, et al., 2008; Bennett and Hogarth, 2009) and the discussions with students following the piloting of our questionnaire.

Students completed the questionnaire by reading a number of statements and then ticking one of five available boxes which were labelled as: strongly disagree, disagree, neither agree or disagree, agree, strongly agree.

The same day that the questionnaires were administered to the year 6 students in each school a smaller number of students (18 students in total) were invited to participate in a group interview which was audiotaped. The interview schedule was developed by drawing on previously validated interview instruments (Gogolin and Swartz, 1992; Colette Murphy and Beggs, 2001; Raved and Ben-Zvi Assaraf, 2011; Kastrup and Mallow, 2016) and then piloted. Perspectives informing the interview schedule were also provided by the literature on attitudes to science (Kind, Jones, Barmby, et al., 2007; Owen et al., 2008; Sjøberg and Schreiner, 2010; DeWitt et al., 2011). Similarly to the questionnaires, drawing on the literature and the discussions with students following the pilot group interview, for the interview questions that were to find out about the constructs and items of interest for which existing instruments were not sufficient (such as expectations of students of secondary science), additional items were developed.

The selection of students for the group interviews was decided with the contribution of class teachers in each primary school to ensure the participation of students with a range of opinions about science (some that liked science, some that did not, some that had a neutral opinion), a range of abilities (higher, lower, medium ability in science), range of SEN status, range of backgrounds and equal number of boys and girls.

3.2 Analysis

Initially, students' responses to the items in each of the components were identified by looking at each question and 'agreement level' of each student with each statement. These were coded (strongly disagree =1, disagree =2, neither agree or disagree =3, agree=4, strongly agree = 5). Most of the items on the questionnaire were positively worded so a higher score showed a higher agreement with the statement and therefore, more positive attitudes. The negatively phrased items were reverse-coded for the purpose of the analysis of the results.

Using the questionnaire items, an 'Attitude towards school science' scale was created to measure students' attitudes towards school science. The scale included items related to all the three domains of attitudes (affective, cognitive, behavioural). The summary of the reliability analysis for the main scales and sub-scales, are shown on table 3.1.

TABLE 3.1: SUMMARY OF RELIABILITY ANALYSIS

Scale	Number of scale items	Cronbach's alpha	Corrected item-total correlation range
Main scales Primary school students' attitudes towards primary school science.	16	.93	.406-.830
Primary school students' attitudes towards secondary school science	9	.93	.216-.637
Sub-scales			
Year 6 students' affective attitudes	8	.90	.530-.849
Year 6 students' cognitive attitudes	5	.78	.401-.679
Year 6 students' behavioural attitudes	4	.78	.350-745

The data collected from questionnaires were analysed by descriptive statistics using SPSS 27.0 (Bryman and Cramer, 2001).

For the analysis of the interview data of the present study, a combined approach -both a priori and emergent data approaches- was used (Thomas, 2003; Braun and Clarke, 2006; Frith and Gleeson, 2011; Blair, 2015; Judger, 2016). The analysis of the interview data started with a range of a priori themes (using pre-applied codes from the literature around students' attitudes towards school science) such as 'science lessons are fun', 'science lessons are interesting', 'science lessons are important'. A number of themes emerged from the data and were also used in the qualitative analysis such as 'like to be actively involved in experiments', 'teachers are strict'. The a priori and emergent themes were then organised in sections for the presentation of the results.

4. FINDINGS

4.1 Questionnaire Analysis

- ***Demographic data***

The collected data included some demographic characteristics of the participants (Table 4.1), their attitudes towards their sciences lessons (Table 4.2) and their expectations of their science lessons next year (Table 4.3).

TABLE 4.1: DESCRIPTIVE SUMMARY OF PARTICIPANTS' DEMOGRAPHIC DATA

	Boys	**Girls**	**Total**
Year 6	91 (57%)	70 (43%)	161

Year 6 students' attitudes towards primary school science

Looking at the questionnaire data, the majority of year 6 students state that they find their science lessons interesting (77%) and important (55.9%). Most students find practical work in year 6 science lessons exciting (87%), and they are looking forward to doing experiments in their science lessons (83.3%). Only 19% of year 6 students stated that they would like to study science at university and have a science-related career.

When thinking about their science lessons next year (in year 7- the first year of secondary school) the vast majority of year 6 students think that they will like science in year 7 (86.9%) and that they will do more interesting experiments (83.2%) using better equipment (87.6%).

Table 4.2 shows in descending order, the means of only the questions that were used to create the 'Primary school students' attitudes towards primary science.

Overall, primary school students' attitudes towards primary school science were found to be positive (i.e above neutral with M=3.27, SD= .79) with students showing interest in science lessons. Students gave the highest scores (and therefore have shown the most positive attitudes) in the questions about interest in science lessons, practical work and experiments in science. For these three statements, students' score was higher than 4 (between 'agree' and 'strongly agree').

TABLE 4.2: DESCRIPTIVE STATISTICS OF YEAR 6 PARTICIPANTS' RESPONSES TO QUESTIONS MEASURING THEIR ATTITUDES TOWARDS PRIMARY SCIENCE SHOWING THE MEANS IN DESCENDING ORDER. (N = 161)

Item number	**Domain**	**Questionnaire item**	**Mean**	**Median**	**SD**	**Corrected item-total correlation**
11	Affective	Practical work in science is exciting	4.45	5.00	.82	.507
12	Affective	I look forward to doing experiments in my science lessons	4.37	5.00	.79	.548
3	Affective	We learn interesting things in science lessons	4.09	4.00	.99	.571

15	Cognitive	Science is an important subject	3.60	4.00	1.05	.562
9	Cognitive	I get good marks in science tests	3.45	4.00	1.17	.541
8	Cognitive	I am good at science	3.37	3.00	1.10	.704
1	Affective	I really enjoy Science this year	3.35	3.00	1.09	.830
2	Affective	Science lessons are fun	3.19	3.00	1.13	.727
13	Behavioural	I like watching TV programmes that are related to science	3.11	3.00	1.31	.406
4	Affective	I look forward to my science lessons	2.71	3.00	1.27	.795
11	Affective	Science is one of my best subjects	2.70	2.00	1.36	.810
5	Behavioural	I would like to do more science at school	2.57	2.00	1.27	.760
16	Behavioural	I would like to have a job working with science	2.53	2.00	1.19	.668
14	Behavioural	I would like to study science at a university	2.43	3.00	1.22	.663
6	Affective	Science lessons are boring*	2.27	3.00	1.32	.710
7	Cognitive	Science lessons are hard*	2.17	3.00	1.07	.433
		'Overall attitudes towards Y6 Science' Mean	**3.27**		**0.79**	
	Note: 1=Strongly disagree, 2=disagree, 3=Neutral, 4=Agree, 5=Strongly agree * Negatively phrased statement so reverse coded here.					

Table 4.3 below shows the mean scores for the year 6 questionnaire items that were used to collect data about primary school students' attitudes towards year 7 science and

what they expected from their year 7 science lessons. The higher the mean, which could be a score between 1 and 5, the higher the agreement level with the statement and therefore, the more positive the attitudes of students.

TABLE 4.3: DESCRIPTIVE STATISTICS OF YEAR 6 PARTICIPANTS' RESPONSES TO QUESTIONS MEASURING THEIR ATTITUDES TOWARDS YEAR 7 SCIENCE WITH MEANS IN DESCENDING ORDER. (N = 161)

Item number	Questionnaire item (N=161)	Mean	Median	SD	Corrected item-total correlation
25	I expect that we will use better equipment in our science experiments in year 7 than in year 6	4.28	4.00	0.75	.593
28	I think I will really like science in year 7	4.27	4.00	0.74	.557
24	I expect that we will do more interesting experiments in year 7 than in year 6	4.14	4.00	0.78	.693
26	I think that we will learn science in more detail in year 7 than in year 6	4.12	4.00	0.98	.501
22	I think that science will be more interesting in year 7 than in year 6	3.98	4.00	1.02	.709
26	I believe that my science teacher in year 7 will have better knowledge of science than my year 6 science teacher.	3.76	4.00	1.10	.280
22	I believe that science will be more exciting in year 7 than in year 6	3.65	4.00	1.11	.531
21	I really look forward to doing science in year 7	3.19	3.00	1.34	.531
29	I don't think I will enjoy science lessons in year 7*	1.86	2.00	0.81	.632
	'Overall attitudes towards Y7 Science' Mean	**3.95**		0.63	
	Note: 1=Strongly disagree, 2=disagree, 3=Neutral, 4=Agree, 5=Strongly agree * Negatively phrased statement – reverse coded				

These results show that year 6 students hold positive attitudes towards secondary school science as the mean for all of these items was higher than '3' with four items scoring a mean higher than '4' (which is between the 'agree' and 'strongly agree' option). Students' attitudes were positive towards all the aspects related to science experiments in year 7. Students also seem to mostly agree that 'Science in year 7 will be more interesting than in year 6' (M=3.98) and that they will 'Learn science in more depth and detail in year 7 than in year 6' (M=4.12). Overall, students were positive towards science in year 7 (M=3.95, SD=.63) particularly agreeing with statements such as 'I think I will really like science in year 7' (M=4.27).

The results provide evidence that primary school students have more positive attitudes towards secondary school science (M=3.95) than they do to primary school science (M=3.27) while they are still in primary school. The paired t-test which was performed to compare the two means shows a mean difference of 13.4% on the 5-point scale (Table 4.4); the difference was found to be statistically significant ($p<0.001$) and with a large (Cohen's $d = 1.1$) effect size (Chen et al., 2010; Wuensch,2015).

TABLE 4.4: COMPARISON BETWEEN PRIMARY STUDENTS' ATTITUDES TOWARDS PRIMARY AND SECONDARY SCHOOL SCIENCE. (N = 161)

Items compared	Mean	SD	Mean diff.	SD	Std. Error Mean	t	df	Sig.	Cohen's d
Year 6 students' attitudes towards Y6 science	3.27	.79	0.67	0.63	0.50	13.48	161	<.001	1.1
Year 6 students' attitudes towards Y7 science	3.95	.63							

- ***The effect of gender***

Independent sample t-tests were used to investigate the effect of the gender on students' attitudes towards school science. According to the results, gender had no significant effect ($p > .05$) and had a small effect size ($d < 0.2$). Looking at the means (Table 4.5), we can see that both boys and girls in year 6 have favourable attitudes towards science (with boys having slightly more favourable attitudes but with no statistical significance).

TABLE 4.5: ATTITUDES TOWARDS SCHOOL SCIENCE AND THE EFFECT OF GENDER

Gender	N	Mean	SD	df	F	Sig (2-tailed)	Cohen's d
Boys	91	3.30	.82	154	.131	.668	.068
Girls	70	3.25	.75				

The association between the attitudes of significant others towards science and students' attitudes towards school science.

A Spearman rank order correlation (Table 4.6) indicates that there are weak/moderate positive relationships between significant others' attitudes towards science and students' attitudes towards school science. Students' attitudes towards science seem to be more associated to their parents' attitudes towards science ($r>.40$, $p<.001$ for most of the questions that concerned parents' attitudes towards science) as the data show a strong positive correlation between them and less to their friends' attitudes towards science with the data indicating a weak correlation between them (Cohen, 1988).

TABLE 4.6: ATTITUDES TOWARDS SCHOOL SCIENCE AND THE EFFECT OF SIGNIFICANT OTHERS

Statement	Mean for the statement	Mean for attitudes towards science	Spearman's rho	Sig (2 tailed)
My parents like science	3.24	3.27	.402	<.001
My parents think I should study a science related degree in university	2.53	3.27	.427	<.001
My parents think that Science is important	3.57	3.27	.372	<.001
My friends like science	2.56	3.27	.261	<.001

The correlation between the between the parental education and students' attitudes towards school science.

One -way ANOVA (Table 4.7), shows that father's education had a significant effect ($p<.005$) and large size effect ($\eta^2=.14$) on students' attitudes towards science. In general, it is observed that the higher the education level of the father (according to the students' response to the questionnaire), the higher the mean score for students' attitudes towards science and therefore, the more positive their attitudes towards school science.

TABLE 4.7: FATHER'S EDUCATION AND THE IMPACT ON STUDENTS' ATTITUDES TOWARDS SCIENCE

Descriptives					**Overall ANOVA**			
Year Group	**Education**	**N**	**Mean**	**SD**	**Df**	**F**	**Sig**	**Eta-squared**
Year 6	Primary	1	3.12	-	121	3.92	**.002**	**.14**
	Lower Secondary	14	3.18	.96				
	Upper secondary	41	3.00	.65				
	Undergraduate	57	3.48	.75				
	Postgraduate	12	3.73	.81				
	Doctorate	2	4.56	.79				

Table 4.8 and figure 4.2 show how students' attitudes towards school science change with their mothers' education level. It is observed that the higher the education level of the mother, the more positive the attitudes of students towards school science, however, this variation in the results was not found to be statistically significant ($p=.006$, $\eta^2=.12$).

TABLE 4.8: MOTHER'S EDUCATION AND THE IMPACT ON STUDENTS' ATTITUDES TOWARDS SCIENCE

Descriptives				**Overall ANOVA**			
Education	**N**	**Mean**	**SD**	**Df**	**F**	**Sig**	**Eta-squared**
Primary	1	2.38	-	124	3.49	**.006**	**.12**
Lower Secondary	6	2.80	.56				
Upper secondary	40	3.05	.61				
Undergraduate	68	3.59	.85				
Postgraduate	14	3.39	.96				
PhD	1	3.06	-				

The affective, cognitive and behavioural attitude domain

The results show (Table 4.9) that students hold, overall positive affective attitudes towards school science (with means higher than '3.00' – between the 'neutral' and 'agree' options). Cognitive attitudes were also positive with means higher than '3.00'. The behavioural component was the one with the significantly lowest mean which indicates that although students have positive feelings and perceptions towards school science, they

do not always have the intention to change the way they act or behave based on this. These findings are further discussed in the 'Discussion' section.

TABLE 4.9: MEANS OF ATTITUDE DOMAINS

Overall ANOVA							
Domain	**N of items**	**Mean**	**SD**	**Df**	**F**	**Sig**	**Eta-squared**
Affective	8	3.52	.86	161	7.37	**<.001**	**.027**
Cognitive	5	3.37	.83				
Behaviour	4	2.66	.96				

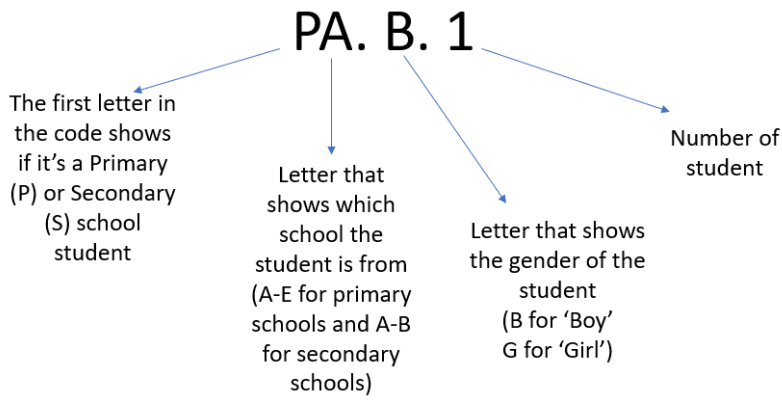
4.2 Interview Analysis

The themes that were identified in the qualitative data (a priori and emerging) were grouped under the following four sections, to help me tell the story of this data (Braun and Clarke, 2006) and to answer the research questions:

- Students' attitudes towards science as a school subject;
- Students' attitudes towards science experiments;
- Students' attitudes towards their science teachers; and
- The impact of family and friends on students' attitudes towards school science.

When referring to students' quotations in the analysis of the interviews, a coded name which ensured anonymity whilst also allowing connections between the schools and the year group was given to the student in question. The code begins with the code for the school, followed by the gender and a number. An example of a coded name used for a primary school student is the one below:

FIGURE 4.1: EXAMPLE OF THE CODED NAME USED FOR A PRIMARY SCHOOL STUDENT



4.2.1 Year 6 students' attitudes towards primary science as a school subject

Most year 6 students (13 out of 18 students) stated that they liked science with the vast majority (16 out of 18) stating that their science lessons in primary school were important for their everyday life as well as their future career or studies. Students showed overall, positive attitudes towards the utility of science (the belief that science is useful for students life and future career) (George, 2006). Both boys and girls mentioned the importance of science lessons. Even the students who stated that they did not like science, they found the subject boring or not as interesting, agreed that science is important, especially for their future career aspirations. As the student below states:

PC.G.1: I don't like science as a subject in school...But I think it is the most important subject. I think it is as important as maths and Greek – it's not like PE. Everything around us, even food…how we cook it and how we grow it is science. I think it's important because if you know science you get a good job when you are older.

4.2.2 Year 6 students' attitudes towards science experiments in year 6

Over half of the students mentioned that they enjoyed science in primary school because they liked doing experiments or they stated that science in primary school was fun when they were doing experiments. The majority of students (15 out of 18) that were interviewed explained that their favourite and most exciting part of their science lesson was when they had the opportunity to do experiments.

Even students who had neutral or less positive attitudes towards science lessons stated that they liked experiments. An example is the year 6 boy below who said:

PC.B.3: I will start with the answer I gave to the questionnaire, Miss… For the question about if we like science in primary school, I chose the 'Neutral' option, Miss. Because

sometimes it is boring, Miss when we are doing only theory and tests are hard, but when we are doing experiments and we discover new things it is so much fun.

The students emphasised on the difference between looking at the experiments as demonstrations and doing the experiments themselves. Students also felt that experiments helped them to understand a scientific concept better.

4.2.3 Year 6 students' attitudes towards the primary science teacher

Discussion with participant students revealed that the relationship between the students and the teacher, as well as the teaching style, are amongst factors determining students' attitudes towards science in primary school with more than half of the participant students mentioning their teacher when talking about whether they liked science or not.

4.2.4 Year 6 students' attitudes towards secondary school science as a school subject

Over half of the year 6 students (12 out of 18) stated that they were looking forward to doing science in year 7. A number of these students (10 out of 12), stated that the reason for this was that they expected science to be more interesting in secondary school than in year 6.

Some of the students stated that the idea of science being more challenging in year 7 compared to year 6 made them feel a bit anxious but for others this was something that got them excited as they saw this as an opportunity to learn new things.

A number of year 6 students mentioned that they expected science to be fun in secondary school. This was the case even when students expected that they would possibly have to study harder for it.

PB.B.1: Next year, science will be more fun and exciting for sure! We will look at new stuff.

A few students, like the boy below, pointed out that they were looking forward to science in secondary school because it would be taught as three different subjects by three different teachers; they perceived this as an opportunity for them to learn more about each science.

PA.B.5: I think science in secondary school will be… more interesting next year because we will do loads of chemistry and biology and physics…[pauses] separately… so we will learn more about it. It will be more interesting and fun.

Certain students expressed the idea that even students who did not like science in secondary school they would have to try hard because of the 'seriousness' of secondary science and the science exam at the end of the year. The year 6 girl below states:

PA.G.6: Science is an examined subject in secondary school so we really need to take it more seriously. Some students might not be so interested- same as in primary school - but they will try harder in secondary school because they will have to take an exam.

4.2.5 Year 6 students' attitudes towards secondary science experiments

Half of the interviewed students seemed to look forward to secondary school science as they appeared to expect that they would do more and more interesting experiments compared to primary school, using better equipment in their science lessons.

Comments, such as the comment of student PA.B.5 below suggest that students expected to be more actively involved in the experimental process in year 7 science and spend less time watching teachers doing experiments; and this was something they were looking forward to in secondary school.

PA.B.5: I believe that we will do more experiments – most of them we will do them by ourselves and not by teacher demonstration.

Finally, students appeared excited to be using a laboratory in secondary school as many of them stated that they had no laboratory in primary school. A number of students claimed that the laboratory would be bigger or better equipped in secondary school and therefore, they were looking forward to it. Some students seemed to relate the presence of a laboratory in secondary school to a better learning science experience.

4.2.6 Year 6 students' attitudes towards the secondary science teacher

Primary school students expressed the idea that whether they would like or not secondary science next year would depend on their secondary school teacher. Some of the students identified this as the main single factor affecting how they would feel about secondary school science. The comments of the students below, are only a few of the comments that linked the science teacher to more fun lessons in secondary school.

PD.B.2: I think science will be more fun in secondary school than in primary school, **IF** [emphasises on 'if'] my teacher is good.

PC.G.1: To be honest, Miss, next year [in secondary school], if science will be more fun or not than primary school it really depends on the teacher. If the teacher loves science, they will make it really fun.

Another factor that seemed to impact students' attitudes towards secondary science was the belief that their secondary school teacher would have better knowledge of science compared to their primary school teacher.

PA.B.5: I can't predict if my secondary school science teacher will be different [from my primary school teacher] because each teacher has different style. But I think that in secondary school, because each teacher teaches their own subject they will know more about it and they will teach it better. In primary school they teach everything in a simpler way.

4.2.7 Year 6 students' attitudes towards secondary science and the impact of family and friends

The results of the interview analysis show that in addition to teacher influence, peer and family influence is also important in forming students' attitudes towards school science. Comments made from the participants indicate that attitudes held by peers or other

family members toward secondary school science or the extracurricular activities they did with their parents/family were influential. Some of the primary school students reported that they expected to like science in secondary school because of what they had heard from their family members or their friends who had already joined secondary school.

5. DISCUSSION

5.1 Attitudes towards primary science

The findings of this study show that primary school students have overall positive attitudes towards primary school science when they are in their final year of primary school. The findings of this study are broadly in line with previous research studies in the field around the world. Hadden and Johnstone (1982) conducting semi-structured interviews and questionnaires, and Galton using classroom observations (2002) also found that year 6 students in the UK reported high enjoyment of school science during their last primary school year. Similar conclusions were drawn in research studies in Australia (Speering and Rennie, 1996; Logan and Skamp, 2008), Spain (Cézar and Pinto, 2017), Turkey (Cermik, 2020), Hungary (Chrappán and Bencze, 2017) and the U.S (Yager and Penick, 1986); these studies also reported that primary school students have positive attitudes towards their primary school science. Some of these research studies are quite old; this shows that 40 years on, primary school students still hold positive attitudes towards primary school science. However, a number of studies conducted in England, Northern Ireland and Oman reveal that although they stay generally positive, primary students' attitudes towards school science decline with age (Galton et al., 2000; Colette Murphy and Beggs, 2001; Murphy and Beggs, 2003).

The year 6 questionnaire data also show that the majority of the students find their year 6 science lessons interesting, again in line with the interview responses which showed that over half of the year 6 students that were interviewed stated that they found primary science (or certain aspects/topics of it) interesting. The results of this study confirm earlier findings (Hadden and Johnstone,1982; Yager and Penick, 1986; Osborne et al., 2003; Dawson, 2000; Anderhag et al.)

The findings are consistent with findings of older (as old as forty years) and more recent studies in the field globally such as the U.S (Hadden and Johnstone, 1982; Yager and Penick, 1986), and the U.K (Hodson and Freeman; 1983; Smail, 1993; Bennett, 2013; Mujtaba et al. 2018). According to Bennett et al., (2013), this is because students believe that the importance of science is 'strategic' (p.26) in following desirable careers. Dewitt et al. (2014), Osborne and Collins (2010) as well as Jenkins and Nelson (2005) also emphasise on the fact that the perception of science lessons as important appear to derive from the possibility of future career benefits rather than their engaging and interesting nature.

Although certain science educators have questioned the purpose of practical work in school science (Wellington, 1998), the vast majority of the year 6 students that participated in the present study, stated that they like practical work in their science lessons with three

quarters of the interviewed students stating that experiments are their favourite part of the lesson. Similar conclusions were drawn by studies conducted in Israel by Agranovich and Ben-Zvi Assaraf (2013), in Australia (Logan and Skamp, 2008), the U.K Braund and Driver (2005), in Turkey (Eren et al., 2015). In line with the findings from the interview analysis of the present study, Campbell (2002) and Ponchaud (2001), have also reported students' positive attitudes towards science experiments, underlining that when primary school students were asked what they liked best in their science lessons, they often stated 'doing experiments'.

In-depth discussion with the students that participated in group interviews revealed that students had positive attitudes towards their school science if they liked their teacher, or the teachers' teaching style. These findings are supported by literature which has a range of examples of studies that show the relationship between teacher and/or teaching style and student attitudes towards their subject. For instance, several studies have documented how enthusiastic science teachers are can increase students' engagement, motivation and enjoyment for their subject (Darby. 2005; Lindahl, 2012; Denessen etl., 2015). This view is not only supported by students but from teachers themselves; qualitative interviews with teachers as part of a longitudinal study (Frenzel et al., 2009), revealed that teachers recognise that their enjoyment for their subject has a positive effect on students' enjoyment for the subject and that the attitudes of students towards the subject depends on the enthusiasm they (teachers) bring to teaching.

In Brunei, Brok et al., (2005), used quantitative data collection methods to provide evidence for the strong, positive relationship between students' perceptions of their science teacher's interpersonal behaviour and their attitudes towards primary science. In England, Osborne and Collins (2010), state that one of the most important themes that emerged from their focus-group discussions with students was the importance of the role played by teachers in stimulating and maintaining students' interest in science which was raised unprompted by pupils in every group. Research in Cyprus has also shown that teacher is among the most important factors affecting students' attitudes towards science (Papanastasiou, 2002).

5.2 Attitudes towards secondary science

The findings of this study show that primary school students have overall positive attitudes towards secondary school science when they are in their final year of primary school.

Participant students in year 6 appeared to have high expectations of year 7 science – this was indicated both by questionnaire and interview results. Students expected that they would do more interesting experiments in year 7, that they would use better equipment in their experiments, that science would be more interesting in year 7 than in year 6 and that they would learn science in more detail than in year 6. Studies that were conducted previously had similar findings; Griffiths and Jones (1994), found out that primary school students had positive attitudes towards secondary science as they were looking forward to the excitement and danger that secondary school practical work would offer. This was evident in students' interview responses, with one characteristically saying with

excitement: 'And you have to dissect frogs' (p.83). Speering and Rennie (1996) , Campbell (2002) and Braund and Driver (2005) also found out that primary school students were looking forward to secondary science as they would be doing 'lots of experiments' and 'better equipment would be used'. Furthermore, students in Galton et al. (2000), stated that the subject they were mostly looking forward to when they joined secondary school was science, explaining that they would be doing experiments 'making bangs and smells' (p. 348).

Primary students in Cyprus (like in the UK) usually have a secondary school induction day during the summer term, just before they move to secondary school. The induction day includes 'typical lessons' for a variety of subjects. Therefore, students' high expectations of secondary science could be a result of the first encounter with the secondary laboratory and experiments on their induction day. However, as Galton (2002), explains these 'typical' science induction days which are full of experiments 'accompanied by dramatic colour changes, dense smoke, loud noises and peculiar smells' (p.256) can create expectations for the first science lessons in the autumn term after transfer which could be unreasonably high. This is also the case in other countries, such as Sweden (Lindahl, 2012), where primary school students have high expectations of secondary science because they get to experience a 'day with experiments' (p.9) towards the end of their final primary year and therefore they expect that secondary science will be just like that.

During group interviews, a number of students shared the idea that they were looking forward to secondary science because it would be more difficult compared to primary school science or because they would be learning challenging things and they appeared to value this as an opportunity to challenge themselves and learn new things. A number of studies have similar findings (Baird et al., 1990; Speering and Rennie, 1996; Galton et al., 2000). Baird et al. (1990), reached the conclusion that when students feel challenged by a science task, they are more engaged in the task.

Finally, in line with a number of studies which were conducted around the world and are already mentioned when discussing students attitudes towards primary science (Keeves, 1992; Martin, 1996; Papanastasiou, 2002; Brok et al., 2005; Lindahl, 2012; Denessen et al., 2015), students have highlighted the importance of their secondary school science teacher, frequently stating that they believed they would like secondary science if they liked their science teacher. Therefore, it is noticed that the teacher is one of the major factors in the current study that impact students' attitudes towards school science, both when they are in year 6 and they are thinking about the reasons that they like science and when they are thinking about their expectations of year 7 science.

The questionnaire analysis showed that students hold, overall positive affective and cognitive attitudes towards school science and that these attitudes are maintained as they move from primary to secondary school. Interview analysis also led to similar findings. With regards to the affective domain, most students, in each of the years, talked about science being interesting or fun (especially the practical aspect of it) and exciting. Also, the majority of students describe science as important for their everyday life or future (cognitive domain).

The behavioural component had the lowest means across the years indicating that

although students hold positive affective and cognitive attitudes towards school science this does not always lead to an action such as the intention to study science at a university or work in a science related job. According to Tavsancil (2010), this could be because every attitude does not need to have a behavioural element. As Triandis (1964) explained, a person can think that painting is something to enjoy, but this doesn't always mean that the person will feel the need to visit art exhibitions or to read books about painting. Therefore, students can have positive cognitive attitudes (e.g., having the perception that science is important, useful for their future, easy) and affective attitudes (e.g., finding science fun, exciting, interesting) but they will not necessarily change their actions based on these positive attitudes. For instance, as this study shows, even if students find science fun and interesting, it does not mean that they will necessarily want to watch science related videos or documentaries. In fact, Xu and Lewis (2011), have suggested that when measuring attitudes for research purposes, removing the behavioural dimension from the attitudes scales serves better to most researchers' purpose. This, according to Sen et al. (2016) could be because it is more difficult for participants to give realistic answers to items related to behaviours than to give answers to items related to feelings and beliefs.

6. CONCLUDING REMARKS

Schools, were undeniably under time pressure when the researcher went in to collect data towards the end of the academic year. Thus, headteachers kindly requested that the researcher only visited the school site once. Therefore, both questionnaire and group interview data were collected on the same day and the choice of interview participants could not be done by the researcher (after an initial analysis of the questionnaire data). Despite the teachers being given directions from the researcher regarding participant selection (for example students of all abilities, equal number of boys and girls, students that like or do not like science), we cannot disregard the fact that there could be bias from teachers when selecting the participant students (with teachers, choosing for example the students that would be more comfortable talking during interviews).

This study looked into the impact of peers on students' attitudes towards school science. However, there was only one question on the questionnaire of the present study regarding peer attitudes ('My friends like science'). Perhaps it would be more appropriate to include a range of questions related to peer attitudes such as importance, interest, career aspirations; this is something that can be looked at in future research. Furthermore, a number of studies state that girls have less peer support for their science interests than boys (Stake & Nickens, 2005; Reinkin and Martin, 2017). The present study did not study the effect of peer group on boys and girls separately. This could, again be looked at in future research.

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THE MANAGEMENT OF THE MUSEUM OF THE OLIVE AND GREEK OLIVE OIL IN LESVOS ISLAND AND ITS CONTRIBUTION TO SUSTAINABLE LOCAL DEVELOPMENT

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ABSTRACT

Purpose: The Piraeus Cultural Foundation is a non-profit public benefit foundation that aims to promote the cultural heritage of Greece with the support of Piraeus Bank. Among the activities of Piraeus Cultural Foundation is a network of Thematic Museums, nine in total. Thematic museums offer a specialized experience since they do not simply have exhibits in their spaces but highlight an important theme or product of their region while also showing its history and the region's history. The Museum combines local tradition with tourism, contributing significantly to attracting visitors and supporting the local community economically. These visitors are aware of and interested in culture, history, local cuisine and tradition. One of the nine thematic museums is the Museum of the Olive and Greek Olive Oil in Lesvos Island. The operation of this museum plays an important and multidimensional role, as it functions as a hub for the preservation and promotion of the local uniqueness and identity of Lesvos. The purpose of this research is to highlight the connection between sustainable local development and the cultural management of a thematic museum.

Design/Methodology/Approach: In this research, a qualitative methodology was followed using interviews, as stakeholders involved in tourism and culture on the island of Lesvos were interviewed as the most competent to answer the questions. This research led to important findings and conclusions.

Results: It is a cultural and entertainment institution, an integral part of the sustainable local community that plays an essential role in preserving and promoting tradition and identity of Lesvos. It also supports the local community by contributing to its development and recognition. Within the framework of strategic planning, the Museum of the Olive and Greek Olive Oil in Lesvos can become a dynamic and modern cultural/archaeological center, strengthening the cultural management of the olive tree and olive oil, promoting sustainable tourism on the island with significant synergies at the local, regional and national levels. With proper management and strategic tourism planning, the Piraeus Cultural Foundation wants to ensure that the visitors' experience will be rich in content. For this reason, the Thematic Museums Network, involved with the local community, focuses on activities that bring benefits to it. New technologies are an integral part of modern society and thematic museums keep pace with their times. New technologies combine interaction and significantly improve the visitor's experience.

Originality/Value: This research explores the management of a major thematic museum of the

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Piraeus Cultural Foundation and emphasizes the museum's main objectives, which are the recording and promotion of cultural heritage, as well as the preservation of Greece's industrial technology, combining the culture of the olive tree and olive oil with the environment and sustainable development. With appropriate planning, it wishes to ensure rich experiences for every visitor to the thematic museums it has in Greece.

Limits: The limits focus on better cooperation between stakeholders, so that they can combine actions and design a specific development strategy with a comprehensive package that will cover all aspects of archaeological/museum tourism and olive tourism.

Keywords: *Archaeological Tourism; Piraeus Bank Group Cultural Foundation, Thematic Museum Network; Museum of the Olive and Greek Olive Oil; Lesvos; Greece; Sustainable Development.*

1. INTRODUCTION

1.1 Cultural Tourism and New Technologies, The Contemporary Role of Museums

Cultural heritage plays a crucial role in the creation and strengthening of social capital, since it inspires and encourages citizens to participate in social life, improves the quality of life of individuals and communities, promotes multiculturalism, contributes to the reduction of social inequalities, supports social participation, intergenerational dialogue and social cohesion, offers opportunities for the development of skills, knowledge and innovation, and functions as an educational tool (Poulaki et al., 2021).

Cultural management concerns the management of cultural identity and cultural heritage. Cultural heritage is usually classified into intangible or non-material elements, such as customs, rituals and traditions, and tangible elements, such as archaeological sites, monuments and other physical remains. Tangible cultural heritage is further distinguished into immovable cultural heritage, for example monuments and archaeological sites, and movable cultural heritage, for example collections and museum artefacts. Movable cultural heritage is the specific object of study of museology. The primary responsibility for the protection and development of cultural management lies with the local community. Management is based on the specific needs of each heritage asset, makes use of different tools, studies and techniques in each case, rests on a clear strategic plan and relies on the collaboration of many different professional fields (Poulaki et al., 2021).

The cultural heritage of a country, as a strong reflection of both its past and its present, encompasses all that is considered important to be passed on to future generations (Rachiotis, Poulaki, 2022). In contemporary conditions, visitors increasingly seek individual and alternative experiences and express a strong desire to live each experience fully during their trip. Tourism is regarded as a powerful factor that shapes practices for managing cultural heritage.

Museums are organized, nonprofit institutions with an educational and aesthetic mission that safeguard cultural artefacts and make them accessible to the public through regular programs (Rachiotis, Poulaki, 2022). Most museums employ specialized staff responsible for the acquisition and conservation of their collections, and they serve as catalysts for cultural awareness, education, skills development, the promotion of open

communities and the enhancement of creativity.

As spaces where cultural heritage is presented and protected, museums enable visitors to expand their knowledge, to meet both the present and the past, and to broaden their intellectual horizons (Poulaki, Lagos, 2016; Poulaki, 2018). In recent years profound changes have taken place in the way museums operate at a global level. Their identity has evolved over time, since their roles have been redefined and they have increasingly acquired an educational and pedagogical function (Rachiotis, Poulaki, Valeri, 2025).

Digital technology contributes in a productive way to the global visibility and dissemination of culture, to the safeguarding of cultural heritage and, through a wide range of interactive applications, offers high quality services to the public (Rachiotis, Poulaki, 2022). The innovative character of new technologies has significantly enriched cultural content and has supported the democratization of cultural creation. New technologies mark the beginning of a new era and contribute to the development of tourism, education and entertainment, as well as to the economic growth of a place.

Museums are being transformed from spaces that mainly store relics and works of art into environments that support education and active learning, and they now operate in a more outward looking manner, giving priority to visitors (Poulaki, 2018).

They are called upon to preserve their collections and maintain their traditional functions, while at the same time combining these with educational values that focus on how their collections can substantially contribute to improving people's quality of life (Hooper-Greenhill, 2000; Alexandri, 2015). A new role for museums emerges, as they become places of learning, education and recreation.

The introduction of new technologies in cultural spaces, and especially in the museum sector, has contributed to their prominence at local, national and global levels. These technologies have allowed individuals to discover exhibits that they might never visit in person (ICOM, 2019). Museum websites have also acquired great importance, since they represent the institution, its collections and its full range of activities.

A wide array of pioneering innovations can now be applied in the museum context, which decisively supports the targeting of new markets and the creation of new experiences and interests for visitors.

Through new technologies, museums have also become more functional for visitors who are physically present in their spaces (Alexandri, 2015; ICOM, 2022). The use of the internet, virtual reality and audiovisual media provide museum visitors with opportunities to participate in activities, to access sources of knowledge, information and entertainment, and to engage in interactive experiences.

1.2 Museums in Greece

Greek museums function as spaces for the safeguarding, preservation and presentation of archaeological finds, works of art, ethnographic objects, as well as historical and scientific collections (Alexandri, 2015). Their role is closely linked to local development and cultural tourism, attracting large numbers of visitors every year (Poulaki, 2018).

Demand for museums in Greece is highly seasonal, with a marked increase in visitor

numbers from June to September and a peak in tourist activity in August (Alexandri, 2015). Museums increasingly orient their operations towards visitor satisfaction, and the fulfilment of visitor needs (Patel, Kumar, 2022; Poulaki, Rachiotis, 2024). As a result, they become more extensive and pleasant spaces through the adoption of new practices and technologies and now constitute sources of inspiration, creativity and research for many visitors (Poulaki, 2018; Rachiotis, Poulaki, 2022; UNESCO, 2023).

Digital technology, as applied in museums and more broadly in the tourism sector, responds to the preferences of different visitor groups, transcends geographical constraints and helps to overcome visitors' learning and physical difficulties. It also supports the transition of culture into the digital realm. A strong interdependence is observed between the level of digitization and the development of a coherent digital strategy, a relationship that presupposes core innovations. In addition, virtual reality and augmented reality offer simulations of real or imagined three-dimensional environments. These technologies contribute to the design of tourism policies for each destination, provide visitors with access to virtual museums and at the same time require a certain level of computer literacy from users. More specifically, augmented reality enriches reality without replacing it and creates specific illusions for the user. A characteristic example of augmented reality in the field of cultural heritage is the augmented representation system for cultural objects, which includes a content layer, a management layer and a presentation layer. Mixed reality constitutes a combination of virtual and augmented reality within the real environment (Poulaki et al., 2021).

Virtual museums play a complementary and supportive role and require the collaboration of archaeologists, museologists and software developers. They collect data of historical, cultural or scientific interest, which can be accessed through electronic means. Four main categories of virtual museums on the internet can be identified. The first is the virtual promotional leaflet of the museum, which provides basic information for visitors. The second is the virtual content of the museum, which consists of digital multimedia material. The third is virtual museum learning, which refers to a website that offers multilayered information to virtual visitors according to their educational level and needs. The fourth is the virtual museum as such, which allows visitors to take a virtual tour of the museum. The method of reflectance-based image transformation provides detailed representations of museum exhibits. The virtual reality modelling language constitutes a three-dimensional format that defines the most common features of a three-dimensional application (Poulaki et al., 2021).

Museum audiences act as active receivers of knowledge through interactive tools. Online promotion is considered crucial, for instance through the museum's website, both for attracting new visitors and for retaining existing ones with a view to encouraging repeat visitation (Poulaki, Rachiotis, 2024). The museum's website should reflect its vision and mission. In Greece most museums use the internet and participate in cultural events at local and regional levels (Alexandri, 2015; Rachiotis, Poulaki, 2024).

Museum planning needs to evaluate existing policies and practices, to study groups that do not visit the museum, to identify the needs and expectations of audiences through systematic research, to recognize changes in the socio-economic environment and to aim

at increasing visitor numbers (Rachiotis, Poulaki, 2022; Rachiotis, Poulaki, 2024).

The main goals of museums can be summarized as follows:

1. Education. Museums provide information and specialized knowledge on the subjects they address, supporting visitors in learning about and understanding these objects of study.
2. Awareness raising. Museums foster respect, understanding and appreciation for the topics they present.
3. Research. Museums support research and contribute to the study of their fields, often in collaboration with research and academic institutions.
4. Conservation and protection. Museums aim to preserve and protect cultural, natural and scientific heritage.
5. Entertainment. Visitors gain engaging experience through interactive activities, exhibitions and educational programs.

Furthermore, museum design is based on historical and cultural analysis, on interactivity through experiences that encourage visitor participation, on architecture and technology, and on constant evolution, since exhibitions are regularly renewed so that visitor interest remains high.

Museums implement a range of good practices such as the following:

1. Sustainable development, which concerns environmental awareness using renewable energy sources, recycling and the reduction of waste of natural resources, as well as cultural preservation by ensuring the conservation and protection of exhibits.
2. Engagement with the local community, where volunteering strengthens visitor interest and collaboration with the local community through numerous events reinforces the connection between museums and residents.
3. Ongoing evaluation and development, since by collecting feedback from visitors, thematic museums are continuously assessed and improve their services, while the frequent renewal of thematic sections helps to maintain visitors' interest.

The Acropolis Museum is a notable example and constitutes a successful case of cultural management. Its purpose is the collection, exhibition and protection of the monuments of the Sacred Rock of the Acropolis in Greece and worldwide, as well as the enhancement of historical and archaeological knowledge. It also organises educational programs and provides a wide range of services for visitors, while its official website allows users to purchase tickets online. In addition, the museum includes a dedicated Information and Communication Technologies Hall.

The digital platform Google Arts & Culture is also of particular importance, since it allows visitors to discover the museum's exhibits in exceptional detail. The Acropolis Museum's website gives visitors the opportunity to explore some of its exhibits either through their digital illustrations or through various digital applications, relates to social media and is available in Greek and English (Alexandri, 2015; Poulaki et al., 2021). The

site uses the Google Art Project application, through which visitors can navigate specific sections of the museum and engage with selected exhibits that are included in the application.

Virtual reality contributes to improving the quality of the museum's services, as well as to strengthening its reputation and the sustainable development of the tourist destination. The museum's contribution to the cultural identity of Greece is noteworthy, since it shapes the past, present and future existence of individuals as a key field of tourism development (Poulaki et al., 2021).

The Acropolis Museum is the only self-funded museum, with ticket revenues constituting its primary source of income, since it does not receive any state subsidy. Visitors can enjoy a direct visual connection with the temple on the Acropolis hill through the extensive glazing of the building. With the development of information and communication technologies, the Acropolis Museum assumes the role of guardian of Greek cultural heritage and serves as a medium for projecting and promoting the country's image abroad (Alexandri, 2015; Poulaki et al., 2021).

Following international trends, the Acropolis Museum has achieved the following objectives:

1. The creation of a website that, as the core channel of communication between the museum and its audiences, offers free and equal access to all information, collections, exhibits and knowledge.
2. The presentation of the multiple dimensions of its collections and exhibits using technological means.
3. The utilisation of the museum's digital material with the aim of enhancing the experiential dimension and the entertainment of both on site and online visitors.
4. The operation of an interactive space of digital exhibits within the museum.
5. The long-term digital preservation of cultural assets through the digitisation of archaeological material related to finds from the Acropolis and its slopes.
6. The installation throughout the museum of appropriate equipment capable of supporting its digital infrastructure (Poulaki et al., 2025).

The Benaki Museum has likewise developed a close relationship with contemporary technologies since 1991, when it founded the first information technology department in a Greek museum. The contribution of new technologies to strengthening the role of the museum in the post-Covid era is particularly significant. Examples of domestic museum practices and the extensive use of new technologies by all its departments have improved its operation.

Fifty thousand objects from its collections, the entirety of its library publications and part of its archival material have been digitally documented according to international standards and are therefore easily searchable and accessible. The initial documentation is continually enriched with new data. Museum Plus functions as the system for documenting and managing the museum's collections and the material of the Photographic Archives Department and was adopted by the Benaki Museum in the context of the project "Digital Documentation and Promotion of the Collections and Archives of the Benaki Museum".

Today the Benaki Museum maintains a modern, functional and interactive website of

high aesthetic quality that fully reflects the museum's identity. It provides information on the history of the institution, informs, showcases and promotes its activities, and offers practical information and multimedia applications.
https://www.benaki.org/index.php?lang=el).

The website presents permanent collections and provides information on current exhibitions and on the services offered. Any interested person can obtain information about opening hours, means of contacting the museum and ways of accessing its physical premises with the help of digital maps and satellite services.

Visitors can also explore options for purchasing tickets. During the period of suspension of onsite operations, the museum introduced an electronic ticketing service so that the public could make transactions using bank cards or PayPal through a dedicated ticketing page, under the initiative "The Benaki Museum opens its doors again with guided tours and exhibitions". (https://www.benaki.org/index.php?lang=el).

The Museum of Greek Culture, the Ghika Gallery, the Museum of Islamic Art and the Yannis Pappas Studio offer 360-degree virtual tours and free audio guides in Greek, English, Spanish, Russian and Chinese. The floor plan of each space helps remote visitors to gain an understanding of the museum environment and to navigate virtually by floor while admiring its treasures.

Within the museum spaces visitors can access audio tours via QR codes. Online visitors can explore the museum's collections by searching for works of art by type, place, period and creator and can appreciate the museum's works, which have now been digitized almost in their entirety with the support of digital technology.

1.3 Network of Thematic Museums of the Piraeus Bank Group Cultural Foundation

Greece hosts many thematic museums, many of which focus on specific aspects of history, tradition, folklore, everyday life, technology and art (Rachiotis, Poulaki, 2025). Representative examples include museums of natural history, historical memory, folklore and culture, traditional occupations, local products and technology.

The Piraeus Bank Group Cultural Foundation is a public benefit, non-profit institution whose operating expenses are, according to its statute, covered by Piraeus Bank. It collaborates with many educational institutions, cultural organisations and research centres in Greece and abroad. Its mission is the protection and promotion of Greek cultural heritage, with particular emphasis on traditional and artisanal or industrial technology.

The Museum Network of the Piraeus Bank Group Cultural Foundation is a constellation of thematic museums located in different regions of Greece, with a focus on traditional techniques, local products, craft and industrial production, the environment and cultural heritage.

Beyond its museums, Piraeus Bank Group Cultural Foundation maintains a Historical Archive and a Library in Athens and organizes research projects, educational programs, publications and cultural events. Through these diverse activities it promotes cultural identity, supports the preservation of know-how and skills and strengthens the interconnections between culture, environment and sustainable development (Piraeus

Bank Group Cultural Foundation, 2025).

Thematic museums increase visitor numbers in each region and provide a strong incentive to visit specific destinations, thereby empowering local communities.

The Piraeus Bank Group Cultural Foundation participates actively in research programs funded by the European Union. Through this involvement it secures specialised expertise for its staff, applies technological innovation in the cultural sector and offers incentives to the regions in which its museums are located to mobilise and develop their cultural tourism. These programs aim to document, safeguard and showcase preindustrial technology and to capitalise on the cultural heritage of each locality. They also seek to ensure rich and meaningful experiences for every visitor to the thematic museums (Piraeus Bank Group Cultural Foundation, 2025).

The contribution of these museums is multidimensional, encompassing cultural, educational, social and economic dimensions. Their core objectives are the documentation and presentation of cultural heritage and the preservation of Greece's artisanal and industrial technology, in ways that connect culture with the environment and with sustainable development.

The Network of Thematic Museums of the Piraeus Bank Group Cultural Foundation comprises nine museums in total, namely:

1. The Silk Museum in Soufli,
2. The Museum of Marble Crafts in Pyrgos on Tinos,
3. The Open-Air Water Power Museum in Dimitsana,
4. The Museum of the Olive and Greek Olive Oil in Sparta,
5. The Museum of Industrial Olive Oil Production of Lesvos,
6. The Chios Mastic Museum,
7. The N. and S. Tsalapatas Rooftile and Brickworks Museum in Volos,
8. The Environment Museum of Stymfalia and
9. The Silversmithing Museum at Ioannina Castle.

The Silk Museum, located in Soufli, is housed in the Kourtidis Mansion. Its permanent exhibition presents all the phases and stages of preindustrial sericulture and silk production. It also traces the history of silk over time and explains how Soufli became an important centre of silk production from the late nineteenth century to the mid twentieth century.

The Museum of Marble Crafts in the village of Pyrgos on Tinos explores the technology of marble, a material that occupies a distinctive place in Greek architecture and art from antiquity to the present day. Its permanent exhibition describes in detail the tools and techniques of marble craftsmanship and places particular emphasis on preindustrial and early industrial Tinos as the most significant modern Greek centre of marble working.

The Open-Air Waterpower Museum in Dimitsana focuses on the importance of waterpower in traditional society. It highlights key pre-industrial techniques that harness water to produce a variety of goods and links these techniques to the history and daily life of the local community over time.

The Museum of the Olive and Greek Olive Oil in Sparta presents the culture, history and technology of the olive and olive oil production in Greece from prehistoric times to the early twentieth century. It holds rare, fossilised olive leaves and precise replicas of

prehistoric, Hellenistic and Byzantine olive presses, as well as a wooden double press with winch from nearby Xirokampi and an olive mill from Lefkada, which together document the survival of animal powered milling practices into the twentieth century (Piraeus Bank Group Cultural Foundation, 2025).

The Museum of Industrial Olive Oil Production of Lesvos presents the industrial phase of olive oil production in Greece and the main stages of processing, namely the crushing of the fruit, the pressing of the olive paste and the separation of oil from water. It emphasises the changes introduced by mechanical power in the production process and highlights the contribution of the local population to this evolving form of production.

The Rooftile and Brickworks Museum is housed in the former N. and S. Tsalapatas Rooftile and Brickworks factory in Volos. It presents everyday life in the factory and documents all the stages involved in producing different types of bricks and roof tiles.

The Environment Museum of Stymfalia, located in the Stymfalia basin, underscores the interdependence of humans and nature, focuses on their harmonious coexistence and aims to foster ecological awareness among visitors. Stymfalia forms part of the European network of protected areas Natura 2000 and its catchment basin constitutes the southernmost mountain wetland in the Balkans.

The Silversmithing Museum at Ioannina Castle occupies two levels of the bastion and the building of the former kitchens. Its purpose is to disseminate knowledge about silversmithing in Epirus, to showcase traditional techniques for shaping and decorating silver objects and to familiarise visitors with the stages of each technique up to the creation of the final product (Piraeus Bank Group Cultural Foundation, 2025).

1.4 Presentation of the Island of Lesvos and its Contribution to Sustainable Tourism Development

Lesvos is the third largest island in Greece and one of the largest in the Mediterranean, located in the northeastern Aegean Sea. It has an area of approximately 1,630 square kilometres and a coastline of about 320 kilometres and is characterised by the diversity of its landscapes and its natural beauty. The island combines rich vegetation, distinctive beaches, thermal springs, olive groves, churches and monasteries, offering a unique synthesis of nature, history and culture.

The island is known for its varied relief, with mountainous areas that provide excellent opportunities for hiking and nature exploration. The presence of extensive plains, such as the plain of Kalloni, supports agricultural production, in particular the cultivation of olive trees and vineyards. The climate of Lesvos is Mediterranean, with mild winters and warm summers, which is favourable both for tourism and for agricultural activities.

Lesvos has a long and rich history that dates back to prehistoric times, with archaeological finds attesting to human presence from the Neolithic period onwards. Important ancient cities, such as Methymna, present day Molyvos, and Antissa, demonstrate the historical significance of the island. Lesvos was also the homeland of several prominent ancient poets and thinkers, including Sappho, Alcaeus and Pittakos.

Tourism development on Lesvos began to emerge in the nineteen fifties, with a

particular focus on Molyvos in the northern part of the island. The aim was to transform Molyvos into a destination for intellectuals and artists. The development model was based on the idea that Molyvos could become an ideal destination for highly educated visitors from Europe, offering dual benefits. On the one hand, it would meet the needs of those seeking tranquility and authentic contact with local residents. On the other hand, the local population would benefit economically and intellectually from this interaction. Many inhabitants of Molyvos abandoned other professional activities, mainly in the primary sector, and turned exclusively to tourism (https://www.mytilene.gr/).

With its rich history, *cultural heritage* and *natural beauty,* Lesvos offers a wide range of tourism forms that respond to different interests and visitors' needs. From cultural and gastronomic tourism to ecotourism and agritourism, the island is an ideal destination for those who wish to experience authentic ways of life and enjoy the variety of activities available (North Aegean Region, 2025).

The *cultural heritage* of the island is also reflected in its architecture. Traditional stone houses, churches and monasteries are significant landmarks. Towns and villages on Lesvos preserve their picturesque character, with narrow cobbled streets and traditional squares. Particularly striking are the mansions, museums and cultural centres in the island's capital, Mytilene.

Dance, song and music are integral elements of daily life on the island and are closely connected with Orthodox religious tradition. The musical idiom of Lesvos has been shaped by influences from Asia Minor and Europe. Dances such as the karsilamas and the ballos and musical instruments such as the santouri, clarinet and bouzouki contribute to a distinctive and rich cultural mosaic.

Painting, pottery and woodcarving are also important components of cultural tourism. Painting is directly associated with the folk painter Theophilos, who lived and worked in a large hollow tree trunk in Karini, an area near Agiasos. Pottery and woodcarving form part of the traditional crafts of Lesvos. Technical knowledge is transmitted from generation to generation, preserving the character of these crafts while modernising tools and equipment. In the area of Agios Stefanos near Mantamados, kilns and large outdoor ovens are still in operation and used for firing ceramics. Visitors can encounter such artisans in Agiasos, Mantamados, Asomatos and of course in the town of Mytilene. A major attraction for visitors is the annual Lesvos ceramics exhibition held in the former olive press at Mantamados (North Aegean Region, 2025).

Poetry, literature and philosophy have also left a strong imprint on the island of Lesvos. Several major poets were natives of the island, including Sappho, Arion, Alcaeus and Odysseas Elytis, who received the Nobel Prize in Literature. In the fields of literature and philosophy, Pittakos and Theophrastos stand out, while in more recent times writers such as Stratis Myrivilis and Ilias Venezis are prominent. A characteristic attraction associated with this tradition is the house where Stratis Myrivilis was born in the village of Sykamia. (https://www.discovergreece.com/el/north-aegean-islands/Lesvos).

Folk culture and tradition undoubtedly play a decisive role. Visitors encounter many expressions of Lesvian culture in activities linked to Orthodox religious life, for example the feast of the Myrrhbearers in Mantamados. Numerous village festivals are organised in

honour of local saints and provide a unique opportunity to experience local culture and customs. Residents and visitors take part in religious ceremonies, dances and shared meals with traditional dishes and experience the island's characteristic hospitality. Many festivals are combined with horse races and the offering of traditional foods in various villages (North Aegean Region, 2025).

The inhabitants of Lesvos keep their traditions and customs alive through a wide range of cultural events and festivals throughout the year. The festival of Methymna and the Aegean Festival in Mytilene include concerts, theatre performances and art exhibitions and attract visitors from Greece and abroad during the summer months. Events related to local social life also take place, such as the Mesotopos carnival with bell-waring performers and folk theatre and the Agiasos carnival with folk poets and performances in the local dialect (https://www.mytilene.gr/).

Museums, archaeological sites and diverse collections are scattered across the island. Notable examples include the Natural History Museum of the Petrified Forest at Sigri, the old and the new archaeological museum in Mytilene and the Museum of Industrial Olive Oil Production in Agia Paraskevi. Among the monuments and archaeological sites are the castle of Mytilene, the castle of Molyvos and the bridge at Kremasti in Agia Paraskevi. Important attractions also include the medieval castles of Mytilene and Methymna, which are significant examples of military architecture (North Aegean Region, 2025).

Gastronomy is an integral part of the cultural identity of Lesvos. Traditional dishes are based on local products and recipes that are passed down from generation to generation. (https://www.discovergreece.com/el/north-aegean-islands/Lesvos). Olive oil from Lesvos is of exceptional quality and is a key ingredient in the local cuisine. Olive groves cover a large part of the island and olive oil production has a long-standing tradition. (https://www.visitgreece.gr/).

The island is also renowned for its cheeses, which are produced with traditional methods. Seafood and fish occupy a central place in the local diet, with dishes such as sardines from Kalloni and shrimp from Sykamia being especially distinctive (North Aegean Region, 2025).

Gastronomic tours, visits to local tavernas and restaurants, as well as cooking classes, offer unique experiences to tourists. The cuisine of the North Aegean is largely influenced by Asia Minor and is distinguished by its particularly intense and distinctive flavours. On the island there is a wide variety of tavernas, restaurants, grill houses and meze establishments, whose menus feature local dishes and small plates strongly shaped by the culinary traditions of Asia Minor.

Ouzo from Lesvos enjoys an international reputation. Local distilleries produce high quality ouzo, which constitutes an integral element of local culture and social life. Ouzo functions as a major attraction for visitors, who can tour the distilleries and taste a range of different varieties (North Aegean Region, 2025).

Several gastronomy-oriented festivals are organised, such as the sardine festival in Kalloni and various ouzo festivals in Plomari and Ano Skala in Mytilene. Thematic museums and beverage producers that are directly associated with local products also constitute an important resource for gastronomic tourism.

In the past the Region of the North Aegean has participated in various certification initiatives for its local products. One example is the "Local Agreement for the Greek Breakfast", implemented nationwide since 2012 under the auspices of the Hellenic Chamber of Hotels. In 2017 the Lesvos Hoteliers' Association presented a localised version of this initiative, the "Local Agreement for the Greek Breakfast of Lesvos". The main objective of this new scheme was to encourage encounters between domestic and foreign visitors through the traditional flavours of Lesvos and its recognised local products.

Lesvos produces several items that carry Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI) labels. These include:

1. Mytilene olive oil (PGI),
2. Ladotyri Mytilenis cheese (PDO),
3. Lesvos feta cheese (PDO) and
4. Lesvos kasseri cheese (PDO).

Beyond these certified products, local dishes are equally significant. Typical examples include stuffed courgette flowers with rice or cheese, sweet pumpkin pies, bourekia pastries, chickpea fritters, "kampounia" with egg, giaprakia, that is vine leaves stuffed with rice or minced meat, tahini pies, oven baked kid goat and many other traditional recipes.

The rich biodiversity and diverse landscape of Lesvos undoubtedly make the island an ideal destination for *ecotourism* and *geotourism.* One of its most impressive natural monuments is the Petrified Forest, which has been designated a protected natural monument and is included in the UNESCO Global Geoparks Network. Located in the western part of the island, it comprises fossilised tree trunks that are millions of years old and offers a unique insight into the history of the Earth. Hiking and cycling are also popular activities on Lesvos, with numerous trails crossing its mountainous and coastal landscapes.

Religious and pilgrimage tourism is particularly developed on the island. Lesvos is a deeply religious place and is therefore dotted with churches and monasteries, the most renowned being the Shrine of Saint Raphael in Thermi, the Monastery of the Archangels in Mantamados, the church of Panagia in Agiasos and the church of Panagia in Petra. Each of these religious sites is distinctive and attracts large numbers of pilgrims (Poulaki, 2018).

Thermal tourism is also well developed. The island has many notable thermal springs. Although not all of them have been fully exploited, those that have been developed constitute important attractions both for visitors and for residents. Typical examples include the Therma Spa facilities, as well as the thermal springs of Polichnitos and Eftalou. The thermal springs of Lesvos are widely known for their therapeutic properties and draw visitors seeking natural treatment and relaxation. Hot baths are considered beneficial for a range of conditions, including rheumatism and dermatological problems. The facilities are equipped with modern amenities, making them ideal for visitors who seek wellbeing and rest within a natural environment. (https://www.visitlesvos.gr/pois/eftalou-aghioi-anargyroi/).

Agritourism on Lesvos offers visitors the opportunity to become acquainted with rural life and to participate in farming activities. Tourists can visit traditional farms, take part in the harvesting of olives and grapes and learn about local agricultural practices. This experience provides an authentic perspective on the lives of the island's inhabitants

and supports the sustainable development of Lesvos. (https://www.lesvosgeopark.gr/gastronomia/agrotouriistikoi-synetairismoi/).

Visitors to Lesvos can also visit traditional farms and observe at close hand the production of local products such as cheese, honey and herbs. These farms organise educational activities and workshops in which tourists can participate in different stages of the production process and learn about the traditional techniques and methods employed. This experience offers an authentic view of rural life and strengthens visitors' connection with local culture (Poulaki, 2018).

There are two main categories of *agritourism* infrastructures on Lesvos. The first category includes agritourism facilities that offer accommodation, such as Kariofyllis Eco Farm in Lepetymnos and the Toumba farm in Gera, which have been operating in this way particularly over the last two years. The second category consists of agritourism infrastructures that do not provide accommodation, such as the Eden tou Mpei estate in Kantri and the Oinoforos estate on the Mytilene–Thermi road. (https://www.lesvosgeopark.gr/gastronomia/agrotouriistikoi-synetairismoi/).

Many agritourism establishments on Lesvos also offer cooking classes, where visitors can learn how to prepare traditional dishes using local products. These activities strengthen visitors' connection with local culture and tradition and provide memorable experiential opportunities.

With its extensive coastline and crystal-clear beaches, Lesvos offers excellent opportunities for *maritime tourism*. The beaches of Eresos, Petra and Skala Kallonis are popular destinations for swimming, sunbathing and water sports. Visitors can also enjoy activities such as sailing, kayaking and diving, exploring the transparent waters and the rich underwater world of the island. Lesvos further offers opportunities for fishing, allowing visitors to participate in traditional fishing activities and to learn about local techniques and the species that are caught in the surrounding seas (Poulaki, Lagos, 2016; Poulaki, 2018).

In recent years Lesvos has also begun to take significant steps towards the development of wine production and *wine tourism*. Wine production on the island constitutes an important component of agritourism. Local vineyards produce high quality wines, which visitors can taste at local wineries. Visits to wineries often include guided tours of the vineyards, demonstrations of the wine production process and tasting sessions that provide deeper insight into the island's wine tradition. Wineries frequently organise additional events, such as wine festivals and wine appreciation seminars, which further enhance the tourist experience. It is also noteworthy that since early 2011 wines from the vineyards of Lesvos have been marketed under the Protected Geographical Indication "Lesvos". (https://www.lesvosgeopark.gr/gastronomia/agrotouriistikoi-synetairismoi/).

Birdwatching tourism is also present on the island. Lesvos hosts a wide variety of bird species, many of which are protected or rare. Its biodiversity is exceptionally rich, with more than 1,400 plant species and over 200 bird species, making the island one of the most important birdwatching destinations in Europe. For this reason, many visitors travel to Lesvos specifically to observe birds in areas with particularly interesting flora and fauna.

The wetlands of the Gulf of Kalloni and of Polichnitos attract numerous species, such as flamingos and herons, and reinforce the island's reputation as a prime site for bird observation (Poulaki, 2018).

Reference should also be made to another form of tourism, namely *lesbian tourism.* When speaking about Lesvos it is difficult not to mention lesbian tourism. Each September an annual lesbian festival is held at Eresos in memory of Sappho, who is often regarded as one of the first openly homoerotic voices in world literature. Large numbers of tourists visit the island specifically to attend this festival.

These are the main forms of tourism that can be observed on Lesvos, although they are by no means the only ones. Lesvos is a resource rich island with many hidden treasures. All these elements act as a strong magnet for tourists and give them the opportunity to learn about the culture, history and natural landscape of the island (Poulaki, 2018).

1.5 Museum of Industrial Olive Oil Production of Lesvos

The Museum of Industrial Olive Oil Production of Lesvos presents the industrial phase of olive oil production in Greece. It focuses on the changes brought about by the introduction of mechanical power into the production process and sensitively highlights the contribution of the local community to this evolving form of industry.

The aim of the Museum is to showcase the country's industrial heritage in the field of olive oil production and to situate this heritage within the broader architectural, social and cultural context of the period (Piraeus Bank Group Cultural Foundation, 2025).

The Museum is housed in the former community olive mill of Agia Paraskevi on Lesvos. The buildings and the mechanical equipment have been meticulously restored. Of particular interest is the way in which the equipment operates and the way the factory evolved from steam power to diesel power.

In the main building visitors learn about the basic stages of olive oil production, namely the crushing of the olives, the pressing of the olive paste and the separation of oil from water. The Museum also presents the flour mill that operated complementarily during the summer months, when the olive mill was not in use.

In the former olive storage areas, the Museum presents the full circle of activities associated with olive production. These include:

1. the cultivation and care of olive trees,
2. the production of by products,
3. the marketing and distribution of olive oil in Greece and abroad and
4. professions and occupations related to olive oil production.

The story of the "Community Machine", as the communal olive mill of Agia Paraskevi was known, is particularly impressive for visitors. It underlines how innovative the practice of community ownership was for its time and explores its impact on the social fabric and on the economic structures of the area.

Young visitors can experience the functioning of the machinery firsthand. They can hear the factory siren calling workers to their shift, watch the machines in operation and explore digital productions that illustrate the different stages in the production of olive oil.

They also can interact with a multimedia application entitled "The Community Machine", which helps them understand how the machinery of the olive mill operates and how the quality of olive oil is checked, for example through an acidity measurement experiment (Piraeus Bank Group Cultural Foundation, 2025).

The Museum organises numerous educational programs with games and activities for schools and group visits, such as the program "From Olive to Oil", through which children gain a clear understanding of the oil production process in the factory. The Museum constitutes one of the most important examples of a site where cultural heritage is harmoniously combined with contemporary technological possibilities. The use of new technologies does not merely support the presentation of information. It functions as a core tool for understanding the history of olive oil production, preserving collective memory and creating a lively and participatory experience for visitors.

First, the Museum uses digital projections and multimedia material to reconstruct the operation of the old steam powered olive mill. Through videos, animations and narrated soundscapes, visitors can observe how the individual machines interacted within the production process, something that would be difficult to convey through static displays alone.

In parallel, interactive information stations have been installed, allowing visitors to explore additional information, to view three-dimensional reconstructions or to interact with virtual models of the machinery. This function in particular enables school students to understand the technology of the period in a playful and engaging way and to enhance their learning experience (Piraeus Bank Group Cultural Foundation, 2025).

Another important feature is the use of virtual tours, through virtual reality or 360-degree projections, which allow school groups or remote visitors to tour the museum without being physically present. In this way the Museum's accessibility is increased and its educational role extends beyond the geographical boundaries of Lesvos.

Moreover, new technologies make it possible for the Museum to digitize and preserve archival material, such as old photographs, documents and technical drawings. Digital archiving ensures the long-term preservation of these valuable records and facilitates access for researchers, educators and other interested parties.

Finally, technology contributes to the design of contemporary educational programs that combine play, interaction and experiential learning. Children can participate in digital activities that help them understand the journey "from olive to oil" in an enjoyable way that is attuned to today's digital reality (Piraeus Bank Group Cultural Foundation, 2025).

Overall, the Museum of Industrial Olive Oil Production of Lesvos constitutes a model example of how tradition can be reinforced and highlighted through new technologies, offering an experience that meaningfully connects the past with the future.

1.6 Primary Qualitative Research, Conclusions and Policy Measures

In this study a qualitative research design based on interviews was adopted, since stakeholders involved in tourism and culture were regarded as the most appropriate respondents. Stakeholders were drawn from the Region of North Aegean, the

municipalities of Lesvos, travel agencies, cultural associations on the island, museums, the hospitality sector, car rental services, the food service sector and other relevant fields. Fieldwork was carried out during the summer months of 2024. The research produced important findings and conclusions.

Thematic museums function as spaces for lifelong learning and recreation. Their primary objective is to maintain a human centred orientation that is grounded in communication with the public and at the same time responds to the needs of visitors. They are fully aligned with contemporary demands and with current trends in museology and museum education.

Digital transformation plays a decisive role in the modernisation of museums. The use of new technologies and digital media is of critical importance. These tools contribute substantially to education and to the strengthening of visitors' knowledge, reflection and emotional engagement through their experiential involvement with local history and culture. Museum programs, activities and exhibitions address multiple age groups, which results in the attraction of a large and diverse audience.

High numbers of visitors from schools and universities demonstrate the experiential way in which thematic museums approach and promote learning. Through appropriate management and strategic tourism planning, the contemporary museum seeks to ensure that the visitor's experience is rich in content.

Cultural tourism contributes to the tourism development of Lesvos. The thematic museum examined in this study constitutes a major attraction for tourists and an important institution for the preservation and promotion of the island cultural heritage. It operates as a cultural and recreational hub and as an integral part of the local community, playing a substantive role in safeguarding and promoting the traditions, identity and particular character of Lesvos.

The use of new technologies and digital media is of decisive importance and has genuinely transformed the Museum of Industrial Olive Oil Production of Lesvos. The museum successfully seeks to make a substantial contribution to education and to the strengthening of visitors' knowledge, reflection and emotional engagement through their experiential involvement with the history and culture of the island. Its programs, activities and exhibitions target a wide range of age groups, which is consistent with the attraction of many visitors. The implementation of activities within the museum space contributes to the promotion of the island and to its further sustainable development.

Technology is recognised as a critical tool for the promotion and development of sustainable tourism. Digital platforms and social media can serve as channels for showcasing agritourism products and for improving tourists' access to rural areas. The integration of technology and innovative practices into sustainable development therefore constitutes an important strategy for enhancing competitiveness.

Within the framework of interactive workshops, school pupils, university groups and tourists can become familiar at first hand with the full process of olive oil production. In terms of tourism promotion, the museum can be incorporated into cultural roots of olive, wine and ouzo in the Aegean region, which link olive culture with the history, gastronomy and natural beauty of Lesvos.

Cooperation among stakeholders is another critical issue and appears to be a continuing challenge for sustainable development on Lesvos. Although some participants acknowledged existing collaboration between local authorities and tourism professionals, the majority considered that there is considerable scope to strengthen partnerships with the museum.

It is emphasised that substantial partnerships with travel agencies, hotels and local organisations are required to attract more visitors. Public and private stakeholders alike express interest in building new synergies with national bodies, with the aim of securing funding and further promoting both the museum and Lesvos.

The museum has already contributed to the creation of new jobs and to the visibility of the institution itself and of the island more broadly. The development of a sustainable tourism plan for Lesvos, with a focus on cultural tourism and on the further promotion of contemporary and low impact forms of tourism development, is considered essential.

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SATISFACTION AND RETENTION: HOW HOSPITALITY BUSINESSES CAN IMPROVE EMPLOYEE SATISFACTION TO REDUCE TURNOVER AND IMPROVE SERVICE QUALITY

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ABSTRACT

The hospitality industry particularly relies on its employees to provide efficient customer service and achieve continuous profitability. However, high employee turnover is an ongoing problem that impacts the quality of the service offered and the stability of the organization. This paper examines factors affecting job satisfaction and turnover intention in the hospitality industry, finding methods to enhance employee satisfaction and reduce turnover rates. By using global examples, theoretical models, including Herzberg's motivation theory, McClelland's needs theory, and cross-sectional research from both developing and developed countries, this paper establishes that to decrease turnover and increase the quality of services, it is crucial to improve working conditions, invest in employees, promote work-life balance, and raise quality of work life. Concisely, the study points to the significance of happy workers in creating long-term, client-oriented hospitality organizations.

Keywords: *Culture; Hospitality Industry; Satisfaction and Retention; Service Quality; Turnover.*

1. INTRODUCTION

The hospitality industry particularly relies on its employees to deliver efficient customer service and sustain profitability. However, high employee turnover is an ongoing problem that affects the quality of service and the organization's stability. This paper examines factors affecting job satisfaction and turnover intention in the hospitality industry and proposes strategies to enhance employee satisfaction and reduce turnover. By using global examples, theoretical models, including Herzberg's motivation theory, McClelland's needs theory, and cross-sectional research from both developing and developed countries, this paper establishes that to decrease turnover and increase the quality of services, it is crucial to improve working conditions, invest in employees, promote work-life balance, and raise the quality of work-life. In brief, the study highlights the importance of happy workers in creating long-term, client-oriented hospitality organizations.

2. LITERATURE REVIEW

High employee turnover continues to be a major worldwide issue in the hospitality industry. It weakens team morale, disrupts workflow, and lowers the quality of customer service. In many cases, the reasons employees leave are preventable, linked to both workplace conditions and how people are managed. According to Suraihi et al. (2021),

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employees in the hospitality sector commonly leave due to stress, dissatisfaction, poor job security, low pay, and lack of motivation. The environment itself can feel exhausting. Long hours, pressure from guests, and physical demands contribute to burnout. Many employees also feel they are not recognized or appreciated, which leads to frustration and disengagement. These factors, combined with low wages and limited benefits, create a cycle in which workers don't feel valued and begin looking elsewhere.

Dwesini (2019) echoes this, pointing out that many hospitality jobs lack intrinsic rewards. Staff often feel overworked and underpaid, and many see little opportunity for advancement. Workers' motivation declines when they don't believe their efforts will lead to growth or recognition. Over time, they leave. Hospitality roles also carry emotional labor. Employees must maintain a friendly, helpful attitude, even when they're tired or dealing with rude guests. Without proper support, this leads to emotional exhaustion. The literature further breaks down turnover causes into different levels. Han (2020) organizes these into three categories: individual, team, and organizational. On the individual level, things like stress, dissatisfaction, and lack of motivation directly influence an employee's decision to leave.

Nevertheless, these often stem from deeper organizational problems. For example, poor leadership or an unsupportive workplace culture can trickle down and affect how a person feels day to day. Team-level issues, such as conflict with colleagues, also play a role, though they are often shaped by how the organization manages people overall.

According to Han (2020), organizational-level factors are among the most powerful predictors of turnover. These include leadership style, HR practices, promotion opportunities, and how transparent the company is with its staff. Trust erodes when employees feel that policies are unfair or that communication is lacking. Once trust is gone, employees begin to disconnect from the workplace. Another crucial point is the economic and operational impact of turnover. Xu et al. (2022) highlight how high turnover weakens an organization's skill base. Every time someone leaves, their knowledge, training, and experience go with them. This creates service gaps.

In developing countries, this issue is even more serious. Fewer job protections and benefits exist, so many workers are in vulnerable positions (Xu et al., 2022). They may stay in poor conditions because there are no better options, but the dissatisfaction still exists under the surface. Once a new opportunity arises, they leave. This creates instability in hospitality businesses that depend on consistency to build customer relationships. Suraihi et al. (2021) also note that turnover affects more than operations; it impacts company culture. Frequent departures send a signal to current staff that something is wrong. Morale drops, leading employees to wonder whether they, too, should leave. This creates a culture of instability, where loyalty is low, and job hopping becomes the norm.

In another study, Djajasinga et al. (2021) emphasize the importance of human resources (HR) practices in preventing turnover. Many hospitality businesses fail to invest in employee development or listen to staff feedback. As a result, workers feel disposable. In a sector that relies heavily on employee-customer interaction, this is dangerous. Hospitality is people-driven. The way staff interact with guests shapes the entire customer experience. When staff turnover is high, that experience becomes inconsistent. Turnover

also has emotional consequences. When coworkers leave often, remaining employees may feel lonely or unsupported. Building strong teams becomes difficult. Dwesini (2019) emphasizes that this kind of disconnection makes it hard to create a sense of belonging at work. People disengage without a sense of belonging, and disengagement is a key early sign of turnover.

ERCSR (Employee-Related Corporate Social Responsibility) has been shown to help reduce turnover when done right. Xu et al. (2022) explain that workers are more likely to stay when companies invest in employee well-being and demonstrate care beyond just paychecks. Things like quality of work life, flexibility, and support for personal growth make a big difference. When staff feels that the company is committed to their well-being, loyalty increases. Therefore, high turnover in hospitality comes from a mix of stress, low compensation, poor support, and lack of career growth. These issues are often deep-rooted in organizational systems and culture. Fixing them requires a proactive and human-centered approach that sees employees as the core of service excellence.

3. DETERMINANTS OF JOB SATISFACTION

Understanding what drives job satisfaction in hospitality is crucial. The industry depends on human interaction. Happy employees create better guest experiences. However, job satisfaction is complex. It depends on both internal feelings and external conditions. Factors like leadership, motivation, wages, and workplace environment all play a role. Recent studies help clarify how these factors interact in the real world.

3.1 Herzberg's Two-Factor Theory and its Limits

Herzberg's two-factor theory has long been used to explain job satisfaction. It splits workplace factors into two groups: motivators and hygiene factors. Motivators include things like recognition, achievement, and opportunities for growth. These are said to increase satisfaction when present. Hygiene factors, like salary, work conditions, and company policy, don't create satisfaction when present; their absence, however, causes dissatisfaction. However, Herzberg's theory may not be applicable everywhere. In fact, new research shows that this model doesn't hold up well in some regions, especially developing countries. Sobaih and Hasanein (2020) tested Herzberg's theory in the Egyptian hotel industry. Their results were surprising. They found that hygiene factors substantially impacted job satisfaction more than motivators. For hotel workers in Cairo, money and working conditions were the top concerns. Recognition and achievement didn't matter as much. In fact, some motivators even caused dissatisfaction (Sobaih and Hasanein, 2020). This suggests that economic context matters. In wealthier countries, workers may focus more on meaning or career growth. However, in developing economies, people first want stability. They want good pay, safe working conditions, and predictable hours. Only when these needs are met do they begin to care about recognition or self-fulfillment. Sobaih and Hasanein (2020) also found that job engagement plays a mediating role. Workers are more engaged and satisfied, regardless of the type of factor present.

3.2 Supervisor Support and Service Efficacy

Supervisors play a key role in how employees feel at work. In the hospitality industry, frontline workers deal with pressure from guests every day. If they feel supported by their supervisors, they cope better. They also perform better. Öksüz et al. (2022) studied this in Turkish hotels. They found that supervisor support directly increased job satisfaction and service efficacy—employees' confidence in their ability to serve guests well. This makes sense. Supportive managers give clear instructions, offer praise, and help solve problems. They also listen. When employees feel heard and backed up, their stress decreases. They are more likely to stay and to do a better job. Interestingly, servicing efficacy was also a partial mediator. In other words, when supervisors offer support, employees feel more capable. And when they feel more capable, they are happier at work (Öksüz et al., 2022). This chain reaction shows how leadership behaviors can indirectly improve overall job satisfaction.

3.3 Quality of Work Life and Intrinsic Motivation

Workplace culture also matters. Employees are more satisfied when their work feels meaningful and when their lives feel balanced. Xu et al. (2022) examine how work-life quality and intrinsic motivation affect job satisfaction and turnover. Their study focused on hotel workers in a developing country. They found that workers were less likely to leave when hotels provided supportive environments, flexible schedules, respectful management, and fair workloads. Intrinsic motivation plays a big part here. This means doing work because it feels good or meaningful, not just for money. When hotel staff find joy or purpose in their jobs, they are more likely to stick around. Nevertheless, intrinsic motivation doesn't happen in a vacuum. It is shaped by how employees are treated.

Xu et al. (2022) found that ERCSR—employee-related corporate social responsibility—was key. When companies care about their employees, staff respond with greater loyalty. ERCSR includes actions such as offering mental health support, investing in training, and supporting work-life balance. These may seem small, but they have a major impact. Workers who feel respected and valued by their employer are more motivated to stay. Xu et al. (2022) argue that both work-life quality and intrinsic motivation act as mediators. They connect company behavior to employee behavior. Simply put, when companies treat workers well, they become happier and stay.

3.4 Work-Life Balance as a Long-Term Satisfaction Driver

Another key factor is work-life balance. Hospitality jobs often involve long hours, night shifts, and weekend work. This makes it hard for employees to maintain healthy personal lives. Over time, this imbalance erodes satisfaction. Knežević et al. (2023) provide a historical review of work-life balance in the hospitality industry. They show how expectations have changed. In the past, work-life balance was rarely discussed. Now it is a major concern for workers.

Knežević et al. (2023) argue that companies must prioritize balance to retain staff. This includes flexible scheduling, time-off policies, and respect for personal time. In many hotel settings, these practices are still rare. Staff are expected to be "always on," especially in guest-facing roles. However, this leads to burnout. Younger employees, in particular, are less willing to sacrifice personal life for work. If they feel overworked, they quit. The study also emphasizes how work-life balance ties back to gender. Many hospitality roles are filled by women, especially in housekeeping and service. Without supportive policies, women often face the added stress of managing home responsibilities alongside demanding shifts. When organizations do not account for this, job satisfaction drops.

3.5 Bringing it all Together

Job satisfaction in hospitality doesn't come from one single thing. It's the result of many interconnected factors. In developing countries, basic needs like pay and safe working conditions are top priorities. Herzberg's model doesn't fully apply here. Hygiene factors play a stronger role than motivators (Sobaih and Hasanein, 2020). Leadership is another major factor since employees want to feel supported by their supervisors. When they do, they perform better and feel better (Öksüz et al., 2022). Strong leaders don't just give orders; they mentor, encourage, and protect their team.

At the same time, companies must look beyond surface-level needs. Offering a good quality of work life and building intrinsic motivation make a huge difference. Workers who find their jobs meaningful are more loyal and more productive (Xu et al., 2022). This is where values like fairness, training, respect, and CSR come into play. Lastly, work-life balance is not optional. It's essential. Employees want time for themselves, their families, and their mental health. They'll look elsewhere if they can't find that in one job (Knežević et al., 2023). Flexible scheduling, reasonable shifts, and a culture that respects time off can go a long way in keeping people satisfied. In short, hospitality job satisfaction comes from how employees are treated and how their work fits into their lives. Companies that understand and act on this will have stronger teams and better service outcomes. Those that don't will keep losing good people.

3.6 Retention Strategies in Hospitality

Maintaining employees is a critical factor in the hospitality industry and a significant challenge. High turnover rates can disrupt operations, reduce service quality, and increase recruitment costs. Thus, the strategies for retaining its customers are crucial. Several elements affect employee retention: satisfaction, training, flexibility, and organizational culture. This section expands on these factors and provides the reader with a better understanding of the strategies businesses in the hospitality industry use to address staff turnover.

3.7 Employee Engagement and Loyalty

Employee engagement and loyalty are crucial to retention. In the hospitality industry context, these two factors are related to job satisfaction, performance, and turnover. In this study, Thi Kim Phuong and Trung Vinh (2020) examined the relationships among job satisfaction, employee loyalty, and job performance in the Vietnamese hospitality industry. According to their findings, job satisfaction enhances employee loyalty and productivity. Consequently, these factors minimize turnover intentions. They also pointed out that the effect of job satisfaction on loyalty was moderated by job position, indicating that different solutions should be adopted for different positions.

For instance, frontline employees who directly deal with clients may require different retention tactics than managerial employees. Implementing retention strategies that focus on employees' roles can help reduce turnover by providing more specific, targeted solutions (Thi Kim Phuong and Trung Vinh, 2020). In this context, employees must be motivated through recognition programs and provided with feedback and career paths that align with their interests and passions. When employees are committed to the organization, they are more likely to remain with it, ensuring that guests in the business establishments enjoy better service.

3.8 Training and Professional Development

Promotion and training, in particular, are widely considered best practices for retaining employees in the hospitality sector. Self- and career-development support from the organization enhances employee retention. According to Djeumo Sandjong (2021), training can help improve employee efficiency, foster togetherness, and promote job satisfaction. Sandjong's study further emphasized the significance of specific, one-to-one, goal-based small-business training in the hospitality industry. Individual coaching sessions may help employees feel important, thereby enhancing job satisfaction and reducing attrition.

Additionally, the study found that employees are more likely to remain loyal to their employers when they feel nurtured by them. This is especially evident among workers who recognize that their skills are being developed and enhanced to support their career planning. Also, making provision for training and career development enhances a worker's perception of career progression (Djeumo, 2021). This kind of progressive feeling can help prevent the high turnover that characterizes many organizations, with many employees leaving.

Training can also serve as a means of passing information between the human resources department and employees, so that workers feel they are understood. Managers should engage their workers in open conversations about their career progression and performance expectations and ensure they have all the tools they need to succeed (Djeumo, 2021). It can also be used to enhance service delivery, as training is a key requirement for improving quality in organizations, especially in the demanding field of hospitality.

3.9 Work-Life Balance

Work-life balance (WLB) is a widely acknowledged component of the organization's performance and is especially considered a key factor in retention. Hospitality industry employees work long hours, including on weekends and holidays, which can make them stressed and unhappy. Enhancing work-life balance is crucial to promoting productivity, employee satisfaction, and tenure. Raghuwanshi (2023) analyzed work-life balance among hotel employees in Delhi to demonstrate that work-life balance affects turnover rates. The research revealed that employees who could balance work and family responsibilities were more committed and less likely to leave the organization.

Flexible working hours, adequate rest breaks, and workers' allowance ensure that employees are well-rested and, as a result, less stressed at work. If individuals believe their personal lives are in their own hands and can be coordinated with their work schedules, they tend to be more effective and committed to their positions (Raghuwanshi, 2023). This reduces turnover and, therefore, improves overall job satisfaction. Incorporating work-life balance policies into hospitality organizations would consequently enhance employee satisfaction and reduce turnover.Therefore, based on ideas highlighted by Budhiraja, Varkkey, and McKenna (2022), it should be stated that work-life balance is a retention tool and an element of talent management. For example, in luxury hotels, work-life balance policies are considered a key aspect of employee management as they are crucial for employee attraction and retention. The employees in the luxury sector value the opportunity to have a fulfilling work-life balance since their occupation is quite challenging. Work-life balance indicators can be useful tools for human resource managers in the creation of retention strategies for employees.

3.9.1 Organizational Culture and Employee-Centric Practices

Culture is a critical factor in employee turnover, and various factors influence it. An organization's culture that fosters a positive attitude towards employees' needs will ensure employees are valued, thereby increasing retention rates. One of the widely researched and implemented types of Corporate social responsibility (CSR) is employee-related CSR (ERCSR) strategies, which are forms of organizational management and communication that aim to improve employees' quality of life and reduce turnover rates in the hospitality industry. Similarly, Xu et al. (2022) noted that hotels that placed greater importance on ERCSR reduced employee turnover intentions by improving work quality and intrinsic motivation.

This study reveals that employees with a positive attitude towards how much an organization cares for them are more likely to be satisfied with their jobs. This results in a lower turnover rate and improved overall employee performance in the organisation. A positive culture that promotes recognition, support, and fairness can enhance job satisfaction and the sense of identification with the organization (Barreto and Mayya, 2024). Moreover, increased positive work relationships and perceived respect from the managers reduce turnover intentions. Therefore, paying attention to employees' well-being

through ERCSR also improves job satisfaction and reduces turnover. Barreto and Mayya (2024) also proposed this view in their empirical investigation into the hospitality sector in Goa. They went further and found that high job satisfaction correlates with repeat business guests and excellent service provision. Happy employees were observed to deliver better service, making guests happy and leading to positive feedback. This, in turn, will positively impact the business and increase its sustainability in the future. Therefore, ensuring employee satisfaction and well-being benefits retention and boosts customer loyalty, both of which are vital to any hospitality company.

3.9.2 The Role of Leadership and Supervisor Support

Another significant component in employee retention is supervisor support. Leadership's contribution to creating a positive organizational climate cannot be overemphasized. Öksüz et al. (2022) established that supervisor support was significantly related to both job satisfaction and service efficacy in the Turkish hotel industry. According to the findings, employees who enjoyed social support from their supervisors had higher job satisfaction and better service performance. This explains why leadership plays a critical role in managing retention strategies.

Managers and supervisors who listen and respond with encouragement and positive feedback foster a culture where employees are encouraged and appreciated. Evidence suggests that when employees have a good relationship with their leaders, they are more likely to remain with the organization and be productive in their positions (Öksüz et al., 2022). Regarding customer service delivery, the relationship between employees and their supervisors can significantly affect the type of service offered in the hospitality industry. Hence, human resource management is crucial for retaining employees within an organization.

Thus, strategies for retaining employees in the hospitality industry should address all the factors that draw employees to the organization. Employee involvement, skill development, creating reasonable working hours, organizational culture, and exercising strong supervisory support help minimize turnover. Thus, by focusing on these areas, hospitality businesses can effectively contribute to the creation of a supportive organizational culture, which, in turn, positively affects employees' job satisfaction and organizational commitment. The literature indicates that retention strategies should be tailored to each employee's requirements, position, organizational culture, and flexibility. If implemented comprehensively, retention strategies can help minimize turnover rates and improve service quality, customer satisfaction, and overall business stability.

3.9.3 The Role of Satisfaction in Enhancing Service Quality

Employee satisfaction has become increasingly crucial for improving the quality of customer service. Satisfied employees produce better results and provide better-quality service to customers, which directly relates to their satisfaction level. This, in turn, leads to improved guest satisfaction and overall business performance (Barreto and Mayya,

2024). Employee satisfaction and service quality are mutually dependent – when the employees are happy, they can deliver excellent service, making the organization successful (Irabor and Okolie, 2019).

Employee satisfaction is important in the hospitality industry because employees provide services to guests. When employees are appreciated and encouraged, they are more willing to work harder to ensure guests have a pleasant experience. Barreto and Mayya (2024) have identified job satisfaction as a key driver of repeat visits and recommendations. Contented employees make happy guests; when attendees are happy, they are more likely to become repeat customers.

According to Irabor and Okolie (2019), companies that invest efforts in increasing job satisfaction are more likely to retain employees with skills. This means that when employees' job satisfaction is high, turnover is lower, leading to lower turnover-related costs. This is especially the case in industries such as the hospitality industry, where high turnover rates can damage business operations and may negatively affect the quality of service offered. Developing a workplace that attracts and retains the best employees is crucial to achieving organizational competitive advantage (Irabor and Okolie, 2019).

Research also supports the notion that, for services to be delivered efficiently and effectively, employees must be satisfied. According to Salamah et al. (2022), customer satisfaction is well correlated with customer retention in the service industry. The research findings can be applied in the hospitality industry. Their studies show that when people are satisfied in the workplace, they create greater value for consumers, which fosters overall consumer satisfaction. The circular relationship between employee job satisfaction, organizational commitment, productivity, guest satisfaction, and customer loyalty is also visible in the hospitality sector.

For instance, Salamah et al. (2022) used a combination of SEM and a neural network to examine service quality in mobile commerce. They identified that factors such as responsiveness and content usefulness affect the perceived quality of service and customer satisfaction. This can be applied to the hospitality industry by focusing on responsiveness to provide better service. When the employees are happy with their jobs and have a positive attitude towards their workplace, they will be more competent to attend to the guests' needs, boosting the quality of service. Hence, to enhance service quality in the hospitality industry, employee satisfaction is a critical factor. Employee satisfaction increases commitment, motivation, and productivity to deliver quality services, ultimately resulting in customer satisfaction and loyalty. According to Barreto and Mayya (2024), this establishes a positive cycle in the best interests of employees and customers. Employee satisfaction is not only about preventing turnover; it is about creating a climate that enables employees to perform at their best.

4. RECOMMENDATIONS FOR PRACTICE

Based on the literature reviewed, hospitality businesses should take a strategic approach to employee satisfaction and retention. Here are several recommendations for improving both employee well-being and service quality in the industry.

4.1 Enhance Hygiene Factors

One of the most fundamental ways to improve employee satisfaction is to address hygiene factors, such as competitive wages, job security, and safe working conditions. These factors are crucial, especially in developing countries where the hospitality industry may face additional challenges in attracting and retaining talent (Sobaih and Hasanein, 2020). When employees feel that their basic needs are met, they are more likely to be motivated to perform well, leading to higher service quality and better customer experiences.

4.2 Invest in Training

Effective training programs help increase employee satisfaction and thus retain them in the hospitality sector. Training makes employees more competent and more committed to, or loyal to, the organization (Djeumo 2021). Through structured programmes for skill development and career progression, employees can be empowered with the tools they need to perform to the best of their capacities. Djeumo (2021) pointed out that it is a focused, individualized, intentional practice with a clear goal, and ensuring that the staff members can communicate with one another. These practices foster a sense of common identity and engagement, leading to higher levels of employee satisfaction and organizational commitment.

4.3 Foster a Positive Work Culture

Effective management of the work environment is important for boosting employee morale and engaging them in their work to achieve the intended goals. Organizations that encourage openness, honesty, and fairness among staff members are likely to have motivated employees. Öksüz et al. (2022) also found that supervisor support directly affects job satisfaction and employees' performance. This article argues that when supervisors offer direction and show concern for employees' welfare, it boosts employees' job satisfaction. Hence, hospitality businesses need to foster cultures of support to improve service delivery and reduce turnover.

4.4 Promote Work-Life Balance

Managing work-life balance has become critical in staff retention across many organisations. Offering flexible work schedules and providing wellness programs ensures employees do not get fatigued or burnt out when their services are in demand, especially in sectors such as hospitality (Raghuwanshi, 2023). This way, employees can support both their work and family needs, resulting in lower turnover and greater loyalty to their organizations. Raghuwanshi (2023) found that work-life balance is positively correlated with employee turnover and organizational performance. The practical implementation of work-life balance in hospitality companies leads to higher employee satisfaction and better

service quality, thereby contributing to greater customer satisfaction and business growth.

4.5 Embrace Employee-Centered Corporate Social Responsibility (ERCSR)

According to previous studies, the implementation of the ERCSR has been shown to positively reduce employee turnover intentions. ERCSR is an acronym for both Employee Relations and Corporate Social and Emotional Responsibility, which focuses on programs that enhance employees' well-being. According to Xu et al. (2022), the present study posits that the actualization of ERCSR can reduce turnover intentions, which is crucial in the tourism and hospitality sectors. Hence, hospitality businesses must include activities that align with employees' orientations to enhance their motivation and organizational commitment. This is not only beneficial to the employees but also enhances the workplace environment and services. For instance, companies can support employee-initiated charity activities or provide opportunities for community service, thereby increasing workers' motivation and fostering their commitment to the company.

Hence, hygiene factors, training, organizational culture, work-life balance, and employee-CSR are ways hospitality businesses can enhance the satisfaction and retention of their human capital. All of these can be interlinked, with every strategy helping to create an environment that fosters employee retention and productivity. Several studies have established that a contented workforce corresponds with an efficient, productive, and therefore more effective service delivery to customers. Therefore, implementing the following recommendations will support the long-term sustainable development of hospitality businesses.

5. CONCLUSION

Therefore, both employee satisfaction and retention are crucial factors that can help hospitality businesses sustain their competitiveness in the long run. Thus, by resolving the issues that make people dissatisfied with their work and by investing in measures that put the focus on employees, companies can dramatically decrease turnover rates, improve service quality, and increase their competitiveness in the market. The study also reveals that a critical, context-sensitive approach to human resource management is required, one that acknowledges employees as organizational assets. This paper will argue that, in the current competitive and dynamic hospitality industry, workforce satisfaction is not only desirable but also imperative. Employee investment is not only compensating and retaining competent workers, but also increasing business success in a competitive industry environment.

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THE DYNAMICS OF THE FUTURE QUANTUM ARTIFICIAL INTELLIGENCE IN THE FOOD AND BEVERAGE INDUSTRY

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ABSTRACT

The intersection of quantum computing and artificial intelligence is an opportunity to change the paradigm in the food and beverage industry. This profound study explores the theoretical background, current and future applications of Quantum Artificial Intelligence (QAI) in the optimization of food production, quality control, supply chain management, and consumer individualization in the hospitality and tourism industries. This research will analyze peer-reviewed articles published between 2020 and 2025 and provide evidence that, even though classical AI has already delivered considerable benefits in operational optimization, quantum computing will deliver breakthroughs in molecular simulation, optimization problems, and predictive analytics. The study has also discovered the main challenges, such as the technological constraints, data quality demands, and integration complexities, with suggestions on a framework of strategic QAI implementation in beverage and food business ventures.

Keywords: *Quantum Computing; Artificial Intelligence; Food and Beverage Industry; Hospitality; Supply Chain Optimization; Molecular Simulation; Tourism Technology; Predictive Analytics.*

1. INTRODUCTION

The food and beverage sector worldwide is on the cusp of a technological revolution driven by the convergence of quantum computing and artificial intelligence. As the hospitality and tourism industries rapidly advance towards personalized, sustainable, and efficient service delivery, the adoption of advanced computing technologies is no longer hypothetical; it is a demand that must be met. The food and beverage sector is experiencing unprecedented pressures, including supply chain vulnerabilities, food safety issues, sustainability pressures, and changing consumer preferences, among others, to the tune of trillions of dollars worldwide. The AI in the tourism market is expected to increase to 13.87 billion USD in 2030, which is a significant growth of 26.7 percent per annum; however, the traditional artificial intelligence systems have already proven to be remarkably competent in addressing the aforementioned challenges and have already demonstrated their ability to do so (Grand View Research, 2025).

The drawbacks of classic computing, however, are evident when tackling the most complex issues in the industry. Food safety, optimization of global supply networks, and large-scale real-time molecular simulations for personalization demand more computing power than is currently available with classical methods. By computing information using quantum mechanical principles of superposition and entanglement, quantum computing offers unprecedented potential to solve these intractable problems. With artificial

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intelligence, quantum systems can transform the food and beverage industry across every aspect, including production and processing, distribution, and the consumer experience.

The study focuses on the dynamics of Quantum Artificial Intelligence applications in the food and beverage industry in the future, with specific attention to the implications of AI use for the hospitality and tourism sectors. The research is based on a recent peer-reviewed literature synthesis to present an in-depth discussion of existing capabilities, new applications, implementation issues, and recommendations for industry stakeholders.

2. QAIT HYPOTHETICAL UNDERPINNINGS

A. Introduction to Quantum Computing

Quantum computing is a radical break from classical computational paradigms. In contrast to classical bits, which exist in the 0 or 1 (zero or one) state, quantum bits (qubits) may exist in a state of superposition and have more than one state at any moment. This property, together with quantum entanglement, in which qubits are correlated in a manner that cannot be achieved with classical systems, allows quantum computers to search exponentially larger solution spaces than classical computers. The food industry will be deeply affected, as one study has shown that simulating a single caffeine molecule with 24 atoms and 1048 quantum states would take the world's fastest supercomputer 100 quadrillion times longer than the universe itself. By comparison, a quantum computer will be capable of doing so with about 160 qubits (Nalla, 2024).

The latest invention in quantum resource estimation by Alice and Bob is an indication of the rapid developments in that area, as it demonstrated that 27 times fewer physical qubits were needed to simulate complex and important biological molecules in fertilizer development, with 2.7 million qubits instead of 99,000 (Coppola, 2025). The development indicates that a feasible quantum implementation of food-related molecular simulations may come sooner than previously thought.

B. Artificial Intelligence Implementation

Artificial intelligence is a group of machine learning, deep learning, natural language processing, and Computer vision systems that enable computers to perform tasks that normally require human intelligence. AI applications have flourished in the food and beverage industry for demand forecasting, quality control, customer service, inventory control, and operational optimization. The study by Filimonau (2025) shows that AI can process and analyze massive amounts of data, revealing patterns of behavior and operations that humans cannot identify, thereby uncovering opportunities that were previously invisible and enabling the optimization of hospitality operations.

Quantum computing and AI synergy lead to Quantum Artificial Intelligence, in which quantum algorithms can contribute significantly to machine learning, and AI methods can improve quantum performance. This can be used to analyze complex data more quickly and is typically applied in fields such as food matrix analysis and supply chain

optimization. Eswaran et al. (2025) note that the integration leads to advanced artificial general intelligence, which is essential in addressing sustainability concerns in tourism and hospitality.

C. Applicability to The Food and Beverage Industry

The complexity of the food and beverage industry makes it a good candidate for QAI application. Production involves complex chemical and biological mechanisms; quality management requires accuracy on a molecular scale; supply chains are global networks with infinite variables; and consumer behavior is nonlinear. Conventional computational methods are not up to this challenge and must make simplifying assumptions that affect the results. The capability of quantum computing to operate on exponentially large solution spaces and AI to provide intelligent pattern recognition and decision-making capabilities opens an arsenal of tools for transforming the industry.

This is proven through recent applications. Quantum algorithm cookers have been developed by researchers offering more than 16.7 million recipe options for brownie cooking on IBM quantum computers using the Bernstein-Vazirani algorithm, which was named the most creative use of quantum technology in 2022 by IBM (Nalla, 2024). Quantum computing has the potential to profoundly influence food formulation and agriculture by solving more complex problems, such as flavor optimization, ingredient substitution, and ingredient replacement. Its applications provide a better understanding of biological systems, increasing knowledge of plant genetics and their resistance to crop diseases.

3. CURRENT ARTIFICIAL INTELLIGENCE APPLICATIONS IN FOOD AND BEVERAGE

A. Operational Optimization and Efficiency

Current AI applications have already revolutionized food and beverage operations, demonstrating the potential for further improvement with quantum capabilities. Hospitality AI point-of-sale systems leverage customer preferences to recommend high-margin products, boosting average check sizes through artificial upselling. Toast, Lightspeed, and Square are platforms that incorporate AI to automate operations and improve customer experiences. Innovative pouring technology can increase profitability by up to 20 percent by reducing liquor loss and optimizing inventory (Pourify, 2025). These systems use machine learning algorithms to identify inefficiencies in the pour, match real-time pours to sales records, and detect shrinkage.

Automation based on AI simplifies kitchen work, optimizes inventory controls, minimizes operational expenses, enhances service quality, and increases profitability. Studies have shown that the adoption of AI in food processing manufacturing has a substantial positive impact on firm performance, raising high-skilled labor ratios and total factor productivity (Liakos et al., 2025). According to the Restaurant AI Playbook, restaurants that use AI at scale reduce food waste by 30-50 percent, cut labor costs by 10-

20 percent, and increase inventory turnover by 15-25 percent (Food & Beverage Magazine, 2025).

Another important use of AI is predictive inventory management. Systems consider historical consumption trends, seasonal changes, forecasts, and local events to forecast demand accurately. This will reduce food waste and maintain sufficient numbers at the same time, serving both economic and sustainability needs. The initial adopters state that dynamic pricing can increase margins by up to 14% when paired with predictive labor scheduling and that AI can optimize resources (Food & Beverage Magazine, 2025).

B. Customer Experience Customization

Artificial intelligence will improve individual client service across industries, especially in tourism and hospitality, by analyzing data to learn about personal preferences. This allows companies to provide customized menu options and offers, which could increase income by twofold through micro-segmentation (ResearchGate, 2024). AI tools, including ChatGPT, can enhance customer service by enabling faster travel decision-making and improving service quality through emotional intelligence and user reviews. Providers are increasingly using new technologies to enhance the guest experience (López-Naranjo et al., 2025).

Among AI technologies, voice-activated technology is most closely associated with increased service quality, as research on robots, chatbots, facial recognition, and sentiment analysis in restaurant settings demonstrates (Cheong et al., 2021). This observation indicates that natural language interfaces are a worthwhile investment for hospitality operators aiming to improve customer satisfaction. Moreover, AI enables analysis of guest feedback to identify overall trends in concerns, enabling targeted improvements with the greatest impact on guest experience (Hotel Management, 2025).

C. Food Safety and Quality Control

The AIs significantly enhance food safety governance through smart regulation and cutting-edge technologies across the supply chain. Machine learning is used in six domains: quality, defect detection, ingredient optimization, packaging sensors, supply chain traceability, and Industry 4.0 models (Liu et al., 2023). Convolutional neural network-based computer vision systems can detect defects faster and more accurately than human inspectors. It has been shown that deep learning helps predict crop diseases and detect food in many forms (Liu et al., 2023). AI systems can analyze spectral data to prevent pests, diseases, and food safety issues.

Predictive analytics enhances food safety by detecting contamination risks using environmental, production, and historical data. AI-powered packaging with embedded sensors and machine learning can predict spoilage in real time and identify microbial risks. Seafood companies are applying AI to predict histamine levels using gas analysis and environmental interpretation, and sharing this information through smartphone applications or smart shelves (Madhu, 2025). This demonstrates how AI is moving towards

analyzing the past and proactive risk management.

D. Sustainability and Supply Chain Management

A combination of blockchain and AI will increase supply chain traceability by using digital tracking technologies such as RFID, GPS, and IoT sensors. Natural language processing and machine learning are applied to transaction records to help AI identify problems, such as unauthorized temperature variations and shipment delays, which are essential to food safety and transparency (Madhu, 2025). In addition, AI streamlines logistics by reducing transportation time, improving demand prediction, and enabling more efficient inventory management, and can identify illegal activities, weather disruptions, and opportunities for predictive maintenance, thereby promoting food distribution efficiency and reducing waste.

Sustainability is a field of application that has become very critical. AI enables identifying opportunities for operational optimization, minimizing resource use, energy consumption, and waste production. The study by Filimonau et al. (2025) underscores the use of AI to enable sustainability shifts in hospitality by maximizing the use of natural and human resources, curbing operational inefficiencies, such as waste, and enhancing corporate market performance. The intersection of technological and sustainability innovations makes AI a necessity for advancing industry towards the Sustainable Development Goals.IV. Food and Beverage Applications in QUANTUM computing.

4. FOOD AND BEVERAGE APPLICATIONS IN QUANTUM COMPUTING

A. Molecular Simulation and Food Chemistry

Quantum computing will transform the food industry by making the more intricate molecular simulations accessible that classical computers cannot simulate. This technology will be able to model complex molecular interactions, giving an insight into critical food quality parameters, including taste, aroma, texture, stability, and bioavailability.

Nestlé is using these abilities in food analysis and aims to enhance products. Quantum computing is applied to food studies through modeling flavor-molecule interactions, the nutritional effects of food processing techniques, and the enhanced conditioning of food at the molecular scale, which may result in novel packaging and storage technologies.

The problem of simulating complex molecules is evident in the case of caffeine, where classical computational bottlenecks are forcing a quantum solution. In the food and beverage industry, this would enable the creation of genetically engineered crops by modeling molecular and protein interactions, simulating the behavior of other proteins, and predicting alterations in nutritional bioavailability during food processing. Quantum simulations have the potential to accelerate the development of sustainable food products that do not depend on animal production, without compromising their nutritional content or consumer appeal.

B. Agricultural Optimization and Food Security

Quantum computing has the potential to transform agricultural biological systems. Food security is a persistent global issue, and areas most affected by weather extremes and natural disasters need more hardy crops and more resilient cultivation methods. The level of analysis of quantum hardware would significantly advance knowledge of the plant genetic code beyond current levels and enable the creation of climate-resistant varieties and the optimization of plant-growing conditions.

Quantum computing in agricultural research can be used in five ways, including optimizing crop planning, molecular simulation for fertilizer and pesticide development, predictive modeling with machine learning, cryptographic security of data, and optimizing the supply chain (Farmonaut, 2025). Haber-Bosch is a major carbon emitter that is a key target of quantum optimization. The work by Alice and Bob suggests the feasibility of designing fertilizers using fewer qubits in simulations. Agricultural data could be analyzed using quantum machine learning to improve crop yield predictions and optimize resource use. It will integrate with 6G-IoT networks to support more innovative solutions in agriculture (Liberty et al., 2025).

C. Complicated Systems Optimization

Optimization in the food and beverage industry includes menu planning, supply chain coordination, and staffing management problems, which have many variables and constraints. They are part of combinatorial optimization, and quantum algorithms, such as quantum annealing and variational quantum eigensolvers, are feasible in the search of large solution spaces for optimal solutions. The potential of quantum computing is also demonstrated in dynamic pricing in hospitality, which can improve current AI-based demand pricing by incorporating real-time factors such as competitor pricing and customer sentiment. Initial indications show that dynamic pricing, together with predictive scheduling, yields higher profit margins.

D. Predictive Analytics and Demand Forecasting

Seasonality, weather, and other nonlinear factors affect tourism and hospitality demand, and effective forecasting of these factors is essential for inventory, staffing, and pricing strategies. Although classical machine learning has improved prediction accuracy, quantum machine learning, specifically quantum neural networks, may further improve predictions by processing large datasets, such as historical reservations and economic indicators. According to research, advanced models can detect hidden patterns and complex relationships, enabling companies to adjust their strategies (López-Naranjo et al., 2025).

The implementation of AI in the restaurant industry to predict demand has already shown its worth, as systems optimize food orders to produce the least waste while guaranteeing availability. With quantum computing, the possibilities can expand further,

enabling the prediction of individual customers' personal preferences in ways previously unachievable, creating truly customized menu suggestions, portion sizes, and service times. This individualized aspect aligns with the growing consumer demand for customized experiences in tourism and hospitality settings.

5. CONVERGENCE: SENTIENT ARTIFICIAL INTELLIGENCE APPLICATIONS

A. Super-Personalized Customer Experiences

The intersection of quantum computing and AI enables hyper-personalization beyond current capabilities. Classical AI systems use customer information to determine preferences and make suggestions, but their capabilities are limited by data constraints and computational resources. Quantum AI may engage much larger datasets, including genomic data to customize nutrition, real-time physiological measurements to promote wellness-focused dining, environmental sensors to optimize ambiance, and historical trends in behavior across a variety of restaurants.

Micro-segmentation in the customer journey could double revenue, but only 35 percent of travel firms have digitalized more than half of the customer journey. Quantum AI can enable full digitalization, delivering customized experiences across all areas of interaction. In beverage services, it may involve taste preferences and context-dependent analysis to provide customized recommendations. QAI can be applied in the hospitality industry, where subjective experience is key, and voice assistants can offer context-based interaction, and room technology can adapt to expected guest needs. Also, restaurants can dynamically optimize menus to increase satisfaction and minimize food waste.

B. High-Level Supply Chain Intelligence

Optimizing the supply chain is one important application of Quantum Artificial Intelligence (QAI) for a food and beverage company. These international supply chains are full of variables, including supplier reliability, costs, storage space, and demand variability, making classical optimization inadequate, particularly in light of real-time information and disruptions. QAI can transform supply chain management by streamlining processes, accounting for uncertainties and risks. It forecasts weather and geopolitical supply disruptions and applies quantum algorithms to quickly identify alternative routes and suppliers, reducing operational disruptions and maintaining service to customers.

It has been highlighted that blockchain technology plays a role in supply chain visibility, facilitating risk detection and tracking through traceability and immutable data storage (Liberty et al., 2025). The combination of quantum computing with blockchain and AI makes a formidable powerhouse: blockchain provides guarantees of integrity and information traceability, classical AI identifies patterns and makes predictions, and quantum computing solves difficult optimization tasks beyond the capabilities of classical algorithms. This integration manages food safety requirements and compiles efficiency and sustainability.

C. Quantum Enhanced Quality Control

In food quality control, analysis of various parameters is needed, including chemical composition, microbial composition, and sensory properties. Although existing AI systems address restricted sets of such parameters, quantum AI offers global-scale analysis, which is essential for complex processed foods. The development of machine learning demonstrated that AI improves firms' performance in food processing by streamlining labor and boosting productivity (Liakos et al., 2025). Quantum technology would also enhance real-time analysis of high-dimensional data across multiple sources, enabling highly accurate quality forecasts and optimal processing parameters.

Another area of quantum computing could be highly valuable to AI-driven packaging systems, which are a new frontier. The existing systems use machine learning models that analyze time-series sensor data to monitor temperature, humidity, gas composition, and microbial activity and predict product decay. Quantum neural networks, especially quantum recurrent neural networks and quantum long short-term memory networks, could process such time-series data with greater precision, enabling more accurate dynamic expiry labels, reduced food waste, and improved safety (Madhu, 2025).

D. Green Performance and Sustainability

Regulations, consumer expectations, and economic factors influence sustainability in the food and beverage industry. AI helps optimize resources and reduce waste, whereas quantum computing augments these efforts by using quantum algorithms to address challenges such as carbon footprint and energy use. Studies indicate that integrating AI and sustainability approaches advances sustainable development objectives and enhances market performance (Filimonau et al., 2025). Moreover, Quantum AI can identify optimization opportunities beyond the reach of classical approaches, including improving production schedules and reducing environmental impacts through ingredient modifications.

The hospitality industry faces specific sustainability challenges due to energy-intensive operations, significant waste, and water use. Quantum AI could optimize HVAC systems based on weather forecasts, occupancy, and guest comfort needs, resulting in reduced energy consumption. In food and beverage operations, the technology may optimally compose menus based on ingredient seasonal availability, transportation, storage needs, and waste, producing dynamically adjusted menus that optimize sustainability without reducing guest satisfaction.

6. CHALLENGES AND LIMITATIONS

A. Maturity and Availability Technology

Quantum computing is still in its infancy and faces technological challenges before commercialization. The error rates are high and sensitive to the environment, making it

difficult to apply in practice. Maintaining quantum coherence is not easy, and decoherence times are short, so complexity is not allowed. Quantum algorithms and computers are expensive and challenging to develop, and are used by a few organisations, especially in food science and hospitality. This knowledge gap, combined with the need to invest in infrastructure and overhaul operations, makes it difficult to integrate quantum computing into the food chain.

The improvement of Alice and Bob, reducing the number of qubits needed to run certain molecular simulations from 2.7 million to 99,000, is a significant breakthrough. However, even 99000 qubits is orders of magnitude above the current quantum computers (Coppola, 2025). It is still unclear when fault-tolerant quantum computers for the food industry will be achieved, with projections ranging from 5 to 20 years depending on the complexity of the application. It is up to the organizations to weigh their efforts on current classical AI capabilities against their preparations for the possibility of future quantum transitions.

B. Information Quality and Accessibility

High-quality data is essential in AI and quantum computing in the food and beverage sector, which is usually constrained by data silos and incompatible formats. These problems undermine the accuracy of AI models, and this is especially lacking in quantum machine learning based on labeled datasets. As is emphasized in the Current Food Science and Technology Report, the efficacy of AI in improving food safety is directly related to the quality of the input data, and biases in training data may only increase the inefficiencies (Dimitrakopoulou and Garre, 2025). Moreover, privacy laws, e.g., GDPR, make the collection of personalized data to use in hospitality more difficult, so sensitive customer data should be managed carefully.

The problem is even more difficult when it comes to quantum AI applications that need molecular-scale data, genetic data, or complicated interaction parameters. The training of quantum algorithms usually requires costly experimental research or simulations that are not possible to perform by most food companies. To create common databases and data standards that would facilitate the development of quantum AI, the involvement of researchers, industry professionals, and policymakers is necessary to ensure that the proprietary information and privacy are maintained.

C. Complexity and Change Management of Integration

The application of quantum AI in food and beverage processes requires new technologies to interact with legacy systems, which are often incompatible with current AI architectures. This would involve major system adjustments, and there would be resistance by the staff who would need to be made aware of the use of AI to augment human capabilities (Food & Beverage Magazine, 2025). Additionally, the distributed nature of the food industry makes adopting technology challenging, and small manufacturers may not have the means to finance quantum AI, leaving them at a market disadvantage compared to larger companies. Some possible solutions involve creating open, cloud-based quantum

AI systems or forming industrial partnerships to reduce infrastructure costs.

Change management concerns not only technical integration but also organizational culture and decision-making processes. Artificial intelligence can suggest solutions that violate human intuition or are off-limits, and AI systems can create conflicts between existing knowledge and algorithmic outputs. In the case of quantum AI, in particular, the unintelligibility of quantum algorithms to specialists can pose challenges to acceptance, as decision-makers cannot fully understand the rationale for recommendations. It is necessary to establish trust by gradually deploying it, transparently validating it, and showing results to achieve successful quantum AI usage.

D. Ethical and Regulatory Issues

Quantum AI also raises major ethical issues, including privacy, algorithmic discrimination, price discrimination, and job losses. Dynamic pricing models may lead to unfair pricing depending on location or customer behavior, as proposed by California lawmakers in 2025. The complexity of privacy preservation is further increased by the integration of AI with quantum computing and other technologies, which can introduce vulnerabilities that compromise security (Electronics, 2024). Moreover, quantum computing has the potential to compromise existing cryptographic systems; thus, the development of quantum-resistant encryption to protect sensitive information is necessary.

Quantum AI automation has implications for employment, and special focus is required on it following the pandemic, which caused more than 62 million jobs in hospitality (Efimova, 2024). Although AI can improve human work, the shift needs retraining and even new social safety nets. The personal service orientation of the hospitality industry can also reduce unemployment, as human qualities such as empathy and creativity are not easily automated. Nevertheless, workforce transition planning is important.

7. STRATEGIC RECOMMENDATIONS AND FRAMEWORK OF IMPLEMENTATION

A. Phased Adoption Approach

Organizations must implement quantum AI in a well-planned process, starting with classical AI, which will create a foundation for quantum AI. The first steps should be devoted to identifying high-value use cases that deliver immediate benefits to AI, such as inventory optimization, demand forecasting, or chatbots that support customers. Such applications establish organizational AI skills, data assets, and familiarity with AI-driven decision-making, equipping organizations to undergo quantum transitions.

Pilot programs allow AI solutions to be tested in a controlled setting before full-scale implementation. Effective pilots demonstrate value to doubting stakeholders and determine integration demands and testing. Pilot programs should have specific, practical objectives within organizations, with emphasis on particular measures such as waste reduction

percentages, revenue growth, or customer satisfaction rates. The lessons learned from pilots are also documented, informing further scaling efforts and preventing similar errors.

As quantum computing matures, organisations must identify specific use cases where quantum benefits offset the cost of adoption and complexity. Early possible uses of quantum AI include molecular simulations, complex supply chain optimization, and advanced personalization. Cloud services can be used to access quantum resources without organizations necessarily building and maintaining their own quantum computers by partnering with quantum computing providers. This method minimizes the capital required and enables experimentation and learning.

B. Data Strategy Development

Quantum AI is essential for implementing comprehensive data strategies. Organizations are advised to audit existing data assets in order to detect gaps and quality problems, standardize the format, and involve scrupulous governance. Unification of data sources requires investment in data infrastructure, such as cloud storage and data lakes. Information gathering should be a trade-off between current classical AI needs and future quantum needs, with sensors for molecular information and for collecting detailed customer information, while adhering to privacy policies. Also, smaller organizations can access the required data through collaborative data-sharing consortia and remain competitive.

Privacy and data security should be actively addressed by implementing encryption, access controls, and audit trails, and by adhering to governmental regulations such as GDPR. Since quantum computing poses a threat to existing cryptographic systems, protocols should begin migrating their encryption to quantum-resistant algorithms (to protect against future quantum attacks). Openness with customers about data use fosters the trust needed to operate personalization applications, whereas well-articulated value propositions foster data sharing, which in turn promotes the effectiveness of AI.

C. Capability Building and Partnerships

The creation of internal quantum AI capabilities would entail long-term investments in human resources, including hiring data scientists, AI experts, and quantum computing specialists, as well as training new personnel. Collaborations with universities enhance expertise and research availability, whereas executive education increases leaders' knowledge of quantum AI. Pilot programs with quantum companies, strategic collaborations with technology providers, and industry peers help first gain access to innovations and shape technology to have practical applications. Industry consortia help with cost-sharing and lobbying for favorable regulatory conditions, whereas research joint ventures are invaluable for driving quantum leaps in development.

The collaboration between food science, hospitality operations, data science, and technology skills in cross-functional teams is necessary to determine useful quantum AI applications and successful implementation. These teams can turn operational challenges into technical requirements, ensuring quantum AI solutions respond to real business needs

rather than technology at its purest. Consistent communication between operation personnel and technologists helps to avoid ability-application disconnect.

D. Ecosystems Activation and Advocacy

Participation in quantum computing and AI ecosystems enables organizations to influence technology development and stay up to date with new trends. In the food and beverage industry, lobbying for related applications promotes quantum companies that address industry needs. Industry associations must work together to adopt quantum AI, develop best practices, and allocate resources to reduce costs. The collective research in a similar area of issues builds industry-wide gains without losing competitive advantage. Also, interaction with the government on research funding and supportive regulatory policies creates an attractive environment for transforming the industry.

Thought leadership in publishing case-studies, speaking at conferences, and being featured in media creates organizational reputation in addition to building industry knowledge. Early adopters who share their successes and failures help subsequent adopters avoid pitfalls and find opportunities. Such knowledge sharing eventually helps the entire industry adopt beneficial technologies more quickly, use them responsibly, address ethical issues, and understand their social effects.

8. FUTURE PERSPECTIVE AND DIRECTION OF RESEARCH

The trends in the development of quantum AI are expected to lead to dramatic changes in the food and beverage sector over the next decade. Molecular simulation applications will become real as soon as quantum computers reach fault-tolerance and scale to thousands of logical qubits. This will allow food formulation, flavor optimization, and safety assessment, which are currently unavailable, partly because of limited molecular understanding and partly because of empirical testing. Combining quantum molecular simulations with AI-based product development may significantly shorten the design time and lower the development cost.

Quantum AI promises to gain supply chain optimization to new heights, to deal with the complexity and require transparency and sustainability - Optimizing large variable spaces with quantum computing. Meanwhile, the uncertainty management will be a competitive advantage. Quantum computing, combined with blockchain, IoT, and AI, will enable autonomous supply chain systems to anticipate disruptions, enhance real-time decision-making, and improve product quality. At the same time, quantum AI will make medical care more personal, and large amounts of data can be analyzed to create fully tailored experiences that dynamically adapt to customer preferences and needs, which may establish new competitive norms in the market.

The potential, however, can be realized by overcoming existing shortcomings through ongoing research in quantum hardware, algorithm design, and application-specific models. The future research directions are to explicitly develop quantum algorithms addressing the problems of the food industry, build detailed molecular databases that facilitate quantum

simulations, explore hybrid classical-quantum methodologies that maximize the facilities of the near future, and address the issue of ethical guidelines that guarantee the responsible utilization of quantum AI. The food and beverage industry should be actively involved in formulating these research agendas to ensure that development aligns with industry requirements and societal values.

9. CONCLUSION

Quantum computing and artificial intelligence (AI) integration will transform the food and beverage industry into an efficient, personalized, and sustainable industry. Although classical AI is already making its mark on the hospitality industry, quantum computing is expected to bring about a multiplied change and address the challenges that could not be addressed previously. The latest literature points to the accelerated progress of both areas until 2025, which implies that organizations should invest in AI and be ready to handle future developments of quantum advancements with data strategies and technological readiness. Technological limitations and ethical concerns are also critical issues, but it is crucial to pursue customer value and operational excellence. Effective change will involve cross-functional cooperation and alliances, which will place companies in a position to use quantum AI as a competitive edge. Organizations re-imagining customer service and resource management will prosper in the changing industry landscape.

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Dr Charalambos Louca, Editor
The Cyprus Journal of Sciences
American College

ISSN 2357-1527

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