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A Mediation Model of the Usability and Intergroup Relation for Online Project Management Community Effectiveness with Microsoft Teams

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Abstract: Effective international project team development and management is a crucial aspect of project management that directly influences the performance and satisfaction of team members. As reductions in travel and physical mobility are prioritized for sustainability efforts, especially after the COVID-19 pandemic, it is of paramount importance to identify and share effective innovative remote, online project management practices. The purpose of this study is to address the scarcity of related research and investigate the impact of Microsoft (MS) Teams usability on team management effectiveness as mediated by intergroup relation. The population of this study includes university personnel that have participated in the Erasmus+ project Benefit, with a sample size of 52 respondents. The data was analyzed using SmartPLS 4.0. The findings revealed that the usability of MS Teams had a direct, positive, and substantial influence on intergroup interactions and team performance. Further intergroup relations have a direct and significant impact on team effectiveness. The findings of the mediation study indicated that the association between MS Teams usability and team effectiveness is partially mediated by intergroup interactions.

Keywords: usability; Microsoft teams; project management; team effectiveness; SEM-PLS

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1. Introduction

Projects are of increasing importance for the economy in the 21st century. Public institutions and businesses prefer to organize a growing number of their activities and personnel around flexible projects [1]. In the context of the European Union, international projects funded through competitive programs such as Erasmus+ (plus) constitute a consistent strategic choice to promote multilateral cooperation across borders towards common objectives with positive economic and societal impact [2].

Projects are temporary actions with concrete goals and unique deliverables that have a clear beginning and end [3]. Project management includes a series of processes organized into five coherent groups: initiation, planning, implementation, monitoring, and closure [4]. Moreover, the successful management of projects addresses several activity areas and processes related to team development, scope achievement, time management and scheduling, cost control, internal and external communications, risk management and quality assurance. Human resources and their relationships through multimodal communication lie at the heart of projects.

However, projects are complex endeavors that face several risks and challenges throughout their duration as diverse obstacles can derail their smooth execution. In fact, there is reported evidence that most projects fail: over half of projects exceed their planned resources or time or fail to deliver the sought outcomes [1,5]. Common problems of

projects include poor or ineffective communication (e.g., unanswered emails), lack of skills, resources, and limited personnel availability due to excessive workload [5]. Projects with multiple intercultural and international teams feature an additional layer of complexity as it results in coordination issues of everyday work [6]. In the context of Europe, there are several project funding frameworks for different purposes such as Horizon Europe for research, LIFE for environmental protection, and Erasmus+ for education and training [2]. International projects that involve academic partners from different countries face additional challenges such as different academic calendars, structures, and work cultures [7].

Projects often involve members with complementary skills and geographically distributed teams in multiple locations called remote or virtual teams [8]. The distance between virtual team members increases complexity in terms of coordination, visibility, communication and cooperation towards the common objective [9]. Virtual teams require multiple technological tools and platforms to address practical aspects of their work related to management, work scheduling and tracking, scope and cost progress monitoring, procurement, quality assurance and control, and written and oral communications within the team, with other internal and external stakeholders, and collaborators [10]. These needs can be facilitated by virtual office suites with interoperable online applications on the web such as Microsoft 365 and Google Apps/Workplace [11]. Suggested tool categories include instant messaging, online meetings, file sharing, and joint calendars [12]. A recent systematic literature review established the importance of emotions and relationships as well as work-life balance and digital well-being as keys for optimal team performance [13]. It verified that one of the most important challenges of virtual teams that can undermine the team's cohesion and achievement is the building of trust that emerges both from formal and informal interpersonal interactions, demonstrating to team members that they value each other and their collective mission [14,15]. Previous research has shown that collaborative activities and meetings in immersive learning environments enable virtual team members to become an online community forged by cordial professional relationships that mitigate physical isolation [16,17].

The recent COVID-19 pandemic introduced an additional burden for project teams as it disallowed travel and regular physical team meetings [18]. As a result, all project teams were instantly transformed into virtual teams [19]. At the same time, the effects of the climate crisis rendered a turn towards sustainable project management with fewer greenhouse gases emissions [20]. Hence, it is of paramount importance to identify and share effective remote project management practices. Specifically, this work responds to the call to identify and understand innovative project management practices with the support of information communication technologies [18]. The goal of this study is to address the scarcity of related research and evaluate the effectiveness of online community software for project management effectiveness. It presents evidence from the capacity-building Erasmus+ BENEFIT project, which featured 10 academic working groups residing in Europe and in the Middle East.

Online community evaluation in the context of project management focuses on three dimensions: usability, team effectiveness, and intergroup relation. The usability of an information system is a critical and well-established measure of its capability to execute with effectiveness its primary functions towards an educational goal [21]. If a software platform has high usability, it can effectively support and enable teams in achieving their mission. Conversely, low usability due to technical or design factors can inhibit project teams' efforts and more importantly demotivate users from the adoption and use of a critical infrastructure.

Microsoft (MS) Teams belongs to the tools that have been widely deployed for remote emergency teaching and the facilitation of the needs of online working groups and communities during the pandemic [22,23]. One of its comparative advantages is that it is incorporated seamlessly within the online MS authentication service and software apps ecosystem. Moreover, in the context of online learning and online, remote project manage-

ment, MS Teams combine one important feature: it can facilitate three essential modes of communication and collaboration [24]:

- Synchronous online meetings through audio and video conferencing;
- Asynchronous, flexible written communication through both public threaded posts and private messaging;
- Shared storage along with collaborative creation and editing of team files.

Additionally, through elaborate user access option modifications, Teams can facilitate the operation of multiple groups, sub-units and divisions in separate, and dedicated spaces (called channels), open or private, within the same online virtual environment (MS Teams). However, the richness of functions does not guarantee its usability for every use case and should be investigated.

Successful project teams have harmonic relationships, communicate openly, can resolve tensions and disagreements and achieve productive results through trust and cooperation [25,26]. In the context of multi-partner, international projects, several autonomous groups co-exist and operate independently. Often members from all partner teams form and participate in committees that are involved with the governance and the performance of essential project tasks that are relevant to most partners such as dissemination, monitoring, and quality assurance [27].

Effective project team development and management is a crucial aspect of project management that directly influences the performance and satisfaction of team members. Project teams undergo different stages: forming, storming, norming, and performing [28]. Upon their creation, in the storming phase teams face challenges related to work culture, priorities, habits, communication style, decision making, and conflict resolution that need to be discussed and resolved [29,30]. This can ensure the prevalence of positive emotions that are instrumental for high performance. The management of successful virtual teams is closely associated with a shared vision and strong feelings of belonging in a virtual community [31,32]. In this direction, principles of effective virtual team management include establishing virtual presence and collaboration and positive team relationships [33,34]. These issues are amplified in the context of multinational projects with multiple autonomous teams of partner institutions with members that need to cross-collaborate in different functions and working groups. In online settings, team stability, commitment, and persistent communication are essential for project success [35].

The study's conceptual framework, depicted in Figure 1, addresses a gap in the existing literature and offers a theoretical examination of the effectiveness of managing online teams, particularly in the context of the COVID-19 pandemic. This framework encompasses both direct and indirect connections between the usability of MS teams and the effectiveness of team management, employing intergroup relations as the mediating variable in the connection.

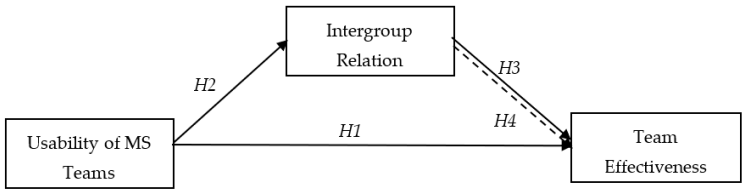

Figure 1. Conceptual Framework.

Based on the conceptual framework, seven research hypotheses were formulated for investigation, namely:

H1. *Usability of MS team has a positive and significant effect on team effectiveness.*

H2. *Usability of MS team has a positive and significant effect on intergroup relation.*

H3. *Intergroup relation has a positive and significant effect on team effectiveness.*

H4. *Intergroup relation mediates the link between usability of MS and team effectiveness.*

2. Materials and Methods

This study employs a causal descriptive technique in the quantitative research paradigm. It aims to clarify the link between variables and to test hypotheses about the effect of one or more independent variables, which include staff gender, category, university, and staff degree on dependent variables (usability of MS team, team effectiveness, and intergroup relation).

2.1. Projects and Online Used Platform

The Erasmus+ project "Boosting Innovation in Education and Research of Precision Agriculture in Palestine" (BENEFIT) began in 2020 during the COVID-19 epidemic and experienced significant physical mobility limitations for most of its duration [36]. Most of the participants in this project have participated in similar projects within Erasmus+ in the past. The BENEFIT project featured academic teams from four European nations, Bulgaria, Czech Republic, Greece, Slovakia, as well as Palestine. As they live in nations with varying workweeks and academic semester patterns, the team members from various cultural and religious backgrounds span across different time zones. A virtual online environment was foreseen for the objectives of this project [37]. Several possibilities were investigated in this situation. Finally, it was agreed to employ MS Teams to orchestrate a virtual community and enable the formal and casual online communication needs of all partner institutions interested and active participants.

2.2. Population and Sampling

The target group of this study consisted of all participants in BENEFIT project from all 10 partner institutions (Table 1). The sampling methodology used was nonprobability sampling with a saturated sample strategy, which encompassed all members of the population, resulting in a sample size of 65 people. Their professional role in the project was as follows: 27 academic staff members, 12 technologists, 9 managerial staff members, and 4 administrative employees. Table 1 depicts the study sample's distribution based on its independent variables, which include staff gender, category, university, and staff degree.

Table 1. Distribution of the respondents according to the demographic variables (N = 52).

Variables	Category	Frequency	Percentage (%)
Gender	Female	20	38.5
	Male	32	61.5
Staff Category	Management	9	17.3
	Teacher/Researcher	27	51.9
	Technical	12	23.1
	Administration	4	7.7
University/Country	ANNU/Palestine	5	9.6
	HU/Palestine	4	7.7
	PASS/Palestine	7	13.5
	PTUK/Palestine	8	15.4
	QOU/Palestine	5	9.6
	SUA/Slovakia	4	7.7

Table 1. *Cont.*

Variables	Category	Frequency	Percentage (%)
University/Country	UCAS/Palestine	4	7.7
	UPAT/Greece	5	9.6
	URAK/Bulgaria	5	9.6
	VEST/Czech Republic	5	9.6
Staff Degree	Bachelor	7	13.5
	Master	21	40.4
	PhD	24	46.2

2.3. Measurement Tools

Following a study of the literature and a survey of online resources [38,39], an item-based questionnaire was created and utilized as a tool to aid data collection and to assess the usefulness of online community software for project management. The original questionnaire's content validity was assessed using a peer review technique online using the pre-test method [40]. It was given to four faculty staff members who served as peer reviewers. The returned notes were collected, and the tool was adapted accordingly. The final version of the questionnaire (Appendix A) had 25 items spread across 3 dimensions, which corresponded to the team's findings about the utilization of the MS Teams during the COVID-19 pandemic. All items used a 5-point Likert-style scale, (1 being "Strongly Disagree" and 5 being "Strongly Agree") [38]. The MS Teams usability construct has 10 components, the intergroup relation contains 7 items, and the team effectiveness contains 7 items. In addition to the questionnaire four items are included as personal and demographic variables (Table 1). The survey started in February 2023 and after three reminders, data collection ended in March 2023. The reminders consisted of written messages to all BENEFIT project members (65) from 10 ten partners' institutions. A total of 52 out of the 65 online questionnaires were returned (80%).

2.4. Statistical Analysis

Data analysis in this study was conducted in two stages after collecting enough data to meet the minimum sample size criterion (N = 52). The first stage was carried out using the Statistical Package for Social Sciences (SPSS version 25). In SPSS the following tasks were performed: descriptive statistics (frequency distribution and mean reporting), inferential statistics (variance analysis and *t* test), a preliminary analysis for measurement reliability and validity, data normality, and the Pearson's correlation analysis. The second step was carried out using the Structural Equation Model-Partial Least Squares (SEM-PLS), using Smart-PLS software version 4.0 for the data analysis [41]. The PLS Path Model consists of two critical components: the evaluation of the measurement model (Outer Model) and the investigation of the structural model (Inner Model) [42].

3. Results

3.1. Data Analysis of the Studied Sociodemographic Profiles

Concerning the respondents' gender, most of the respondents were male (61.5%), doctoral degree holders (46.2%), and (51.9%) were teacher/researcher, followed by technical (23.1%), management (17.3%), and administration staff (7.7%). In terms of the country and the university the participants belong to, 15.4% were from PTUK, 13.5% were from PASS, and 9.6% from each of ANNU, QOU, UPAT, VEST and URAK universities. While 7.7% of the respondents were from each of UCAS, HU, and SUA universities. Most participants were from Palestine (63.5%), wile 36.5% were from European countries (Table 1). It is usual for samples from higher education to comprise more PhDs in comparison to other educational levels. Thus, it can be argued that the sample represents the wider population of partner Universities in the BENEFIT Project.

3.2. Preliminary Data Analysis

For data analysis in SmartPLS4, a method called consistent bootstrapping was used. This method follows the methodological direction suggested by Ref. [43]. The choice to employ consistent bootstrapping was based on the study objective of accurately estimating the parameters of the reflective measurement model. This procedure was recommended for its consistency and reliability in estimating parameters. Furthermore, the use of consistent bootstrapping is widely recognized as a reliable method for evaluating models in structural equation modeling, as explained in the handbook on PLS-SEM [44]. The open reporting of the consistent bootstrapping approach improves the dependability and comprehensibility of the statistical analyses carried out in this study, hence enhancing the overall methodological consistency of the research.

The significance threshold was set at 0.05. We also established a threshold of 0.708 for outer loadings to ensure indication reliability. Any indicators in the 0.40 to 0.78 range were evaluated for removal, but only if their removal resulted in improvements in composite reliability and Average Variance Extracted (AVE) over the suggested levels indicated by Ref. [42]. As indicated in Table 2, the outer loadings of the majority of reflective structures are above the crucial criterion of 0.708. However, we discovered four indications connected to MS Team Usability, one item connected to team effectiveness, and two items connected to intergroup relation with loadings below this level, forcing us to remove them to improve the AVE of the corresponding constructions.

Table 2. Outer loading model final stage.

	Intergroup Relation	MS Team Usability	Team Effectiveness
MS_U10		0.914	
MS_U4		0.65	
MS_U6		0.818	
MS_U7		0.91	
MS_U8		0.831	
MS_U9		0.453	
TE1			0.749
TE3			0.851
TE4			0.857
TE5			0.793
TE6			0.602
TE7			0.727
TIn1	0.958		
TIn2	0.749		
TIn3	0.602		
TIn4	0.729		
TIn7	0.737		

Usage of MS Teams: MS_U4—MS_U10, Intergroup relation: Tin1—Tin7, Team effectiveness: TE1—TE7.

Finally, our measurement model demonstrated good internal consistency reliability, as proven by Cronbach's alpha values of 0.901 for Usability of MS Teams, 0.877 for Intergroup Relation, and 0.894 for Team Effectiveness. Similarly, our composite reliability values demonstrated good internal consistency dependability, ranging from 0.89 (Intergroup Relation) to 0.92 (Usability of MS Team). These results collectively demonstrate the high level of internal consistency reliability for all four reflective constructs.

3.3. Convergent and Discriminant Validity Assessment

Table 3 shows the results of the convergent validity evaluation, which is based on the Average Variance Extracted (AVE) values. The AVE values for the three variables studied (MS Team usability (0.608), intergroup relation (0.583), and team effectiveness (0.590)) are all above the minimal criterion of 0.50. This suggests that the measures for the three reflective constructs have a high degree of convergent validity, implying that the

corresponding latent variables account for more than half of the variance in the relevant indicators. Furthermore, the square root of the AVE for each construct is greater than the correlation coefficients between that construct and the others in Table 3. These elevated values confirm the adequacy of the divergent validity of the constructs.

Table 3. Cronbach's alpha, Composite reliability, and Average variance extracted (AVE).

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)	Result
Intergroup Relation	0.877	0.890	0.583	Reliable
MS Usability	0.901	0.922	0.608	Reliable
Team Effectiveness	0.894	0.903	0.590	Reliable

The Fornell–Larcker criterion is a commonly employed technique for evaluating discriminant validity in the field of structural equation modeling. The process entails comparing the square root of the Average Variance Extracted (AVE) for each latent construct with the correlations between that latent construct and the other latent construct. In Table 4, the values in the brackets show the square root of the Average Variance Extracted (AVE) for each latent variable. The values that are displayed without the use of brackets, on the other hand, represent the correlations between the latent variables. Examining the intergroup relation, its AVE has a square root value of (0.763), which is higher than its correlations with MS team usability 0.569 and team effectiveness 0.750. This pattern remains true for the other latent constructs as well. The square root of the average for MS team usability (0.779) is higher than its associations with intergroup relation 0.569 and team effectiveness 0.741. Moreover, the square root of the average variance extracted (AVE) for team effectiveness (0.768) surpasses its associations with intergroup relation 0.750 and MS team usability 0.741.

Table 4. Fornell–Larcker criterion.

	Intergroup Relation	MS Team Usability	Team Effectiveness	
Intergroup Relation	0.764	(0.763)		
MS team Usability	0.569	0.780	(0.779)	
Team Effectiveness	0.750	0.741	0.768	(0.768)

These data suggest that the indicators of each latent variable have a stronger correlation with their corresponding latent variables than with other latent variables. Put simply, the Fornell–Larcker criterion in Table 4 confirms that our measurement model has discriminant validity. This validation strengthens the overall reliability of our study. This result highlights the efficacy of selected indicators in accurately measuring the distinct variability of each underlying construct without being excessively affected by other constructs. The credibility of our model is further supported by its strong fit indices, which enhance the reliability of our findings. The assurance of measurement validity increases our confidence in drawing accurate conclusions regarding the relationships between the variables.

Table 5 displays the loadings and cross loadings for each indication. As an illustration, the MS U10 indicator showed the greatest value for the loading of its related construct—MS Usability (0.914). The cross loadings with other constructs were observed to have lower values of 0.509 (intergroup relations, and 0.685 (team effectiveness). The same conclusion applies to the other measures of intergroup relations, and team effectiveness. Thus, the establishment of discriminant validity has been confirmed.

Table 5. Loading and cross-loading of indicators.

	Intergroup Relation	MS Team Usability	Team Effectiveness
MS_U10	0.509	0.914	0.685
MS_U4	0.458	0.650	0.414
MS_U6	0.460	0.818	0.610
MS_U7	0.458	0.910	0.719
MS_U8	0.443	0.831	0.638
MS_U9	0.337	0.453	0.275
TE1	0.442	0.671	0.749
TE3	0.661	0.609	0.851
TE4	0.723	0.558	0.857
TE5	0.507	0.673	0.793
TE6	0.459	0.440	0.602
TE7	0.640	0.447	0.727
TIn1	0.958	0.520	0.739
TIn2	0.749	0.465	0.532
TIn3	0.602	0.346	0.449
TIn4	0.729	0.376	0.578
TIn7	0.737	0.449	0.530

Usage of MS Teams: MS_U4—MS_U10; Intergroup relation: Tin1—Tin7; Team effectiveness: TE1—TE7.

3.4. Assessment of the Structural Model

The study looked at the R^2 values, which measure the proportion of explained variance in Team effectiveness and found it to be significantly high at 0.709. As a result, the model revealed a great ability to explicate the endogenous latent variables. Changes in R^2 values were obtained to estimate the effect sizes (f^2) of the predictors. Table 6 shows that the effect sizes (f^2) linked with the endogenous latent variables ranged from 0.479 to 0.550. These results indicate a moderate impact size (f^2) of the predictors [42]. Notably, the variable Intergroup relation had the most significant influence (f^2 = 0.550) on team effectiveness, whereas the impact of MS team usability on intergroup relation was (f^2 = 0.479).

Table 6. R^2 values, Q^2 predict, and the effect size (f^2).

	R-Square	R-Square Adjusted	(f^2)	Q^2 Predict
Intergroup Relation	0.324	0.310		0.367
Team Effectiveness	0.709	0.697		0.156
Intergroup Relation -> Team Effectiveness			0.550	
MS team Usability -> Intergroup Relation			0.479	
MS team Usability -> Team Effectiveness			0.500	

Table 6 also includes the results of the blindfolding method, which was used to test the accuracy of the model's predictions. The result revealed that all Q^2 values were greater than zero, validating the effective reconstruction of observed values. These findings, as shown in Table 6, highlight the model's predictive power.

3.5. Structural Model Evaluation

The structural model evaluation is linked to hypothesis testing, with the goal of determining the influence of independent variables (Exogenous) on the dependent variable (Endogenous). The Second Order technique, which involves assessing latent variables based on dimensions and indicators, was used in this study to examine the Inner Model or hypothesis testing. The consistent PLS-SEM (PLSc-SEM) algorithm was used for the evaluation on the basis of 5000 resamples in this investigation, which was made possible by the SmartPLS 4.0 program.

Testing the Direct and Indirect Effects among Variables

In the context of using structural equation modeling, it is crucial to distinguish between the mediation effect and the indirect influence. These concepts represent separate elements of how variables interact with each other. A mediation effect occurs when an independent variable influences a dependent variable by means of a mediator variable. This phenomenon can occur through both direct and indirect means [45]. Although mediation and indirect effect have different meanings, scholars often use these terms interchangeably because of their linguistic similarities and the fact that both direct and indirect effects are considered in mediation [46]. The use of interchangeable terminology is justified since the ultimate objective is to quantify the total impact of the independent variable on the dependent variable along a specified pathway. In this study both terms are used interchangeably to precisely capture the complex interaction between different components.

As shown in Figure 2, and presented in Table 7, the structural model analysis shows that the three direct paths are statistically significant at the 0.001 level. Tables 7 and 8 show the result of the direct and indirect effect respectivelly. The next sections elaborate on and explain these findings in further detail.

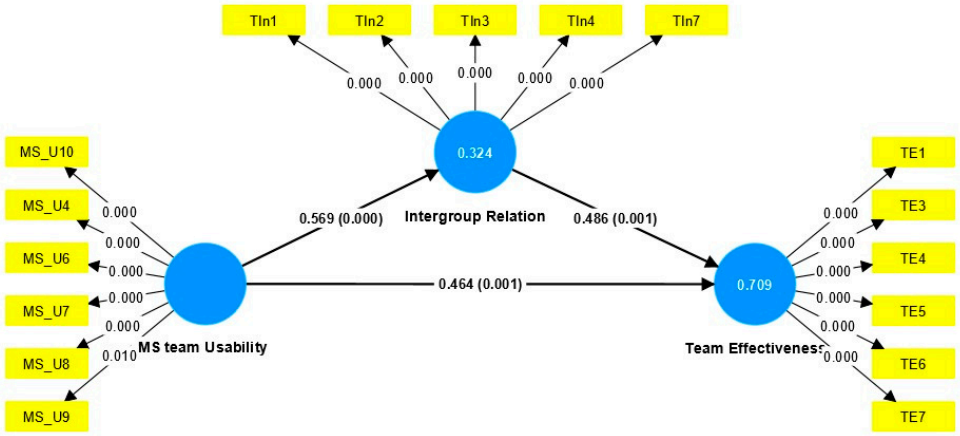

Figure 2. The inner model. Source: Smart-PLS4.0 1-9-2023.

Table 7. Results of direct relationship testing.

	Hypothesis	Path Coefficient	*p* Values	Result
H1	MS Teams Usability -> Team Effectiveness	0.464	0.000	Accepted
H2	MS Teams Usability -> Intergroup Relation	0.569	0.001	Accepted
H3	Intergroup Relation -> Team Effectiveness	0.486	0.001	Accepted

Table 8. Results of indirect effect.

		Standard Deviation	*T* Statistics	*p* Values	Result
H4	MS team Usability -> Intergroup Relation -> Team Effectiveness	0.095	2.913	0.004	Accepted

4. Discussion

4.1. The Direct Link between the Usability of MS Teams and Team Effectiveness

The results show that the path coefficient of the impact of usability of MS Teams on team effectiveness is 0.464. This means that a higher level of MS Teams usability is positively associated with a high level of team effectiveness. In addition, the findings of the hypothesis testing reveal that the *p*-value for the impact of the usability of MS Teams on team effectiveness is 0.000, which is less than the significance threshold of 0.05. This indicates that the usability of MS Teams significantly affects team effectiveness. Consequently, if there is a higher level of usability of MS Teams, it is likely that team effectiveness will significantly improve. Thus, H1 is accepted. To discuss this result, many empirical studies have examined the link between usability of technology, such as MS Teams, and its effect on team effectiveness. For example, a study on pre-service teachers' perceptions of MS Teams effectiveness, found that the usability of these tools and learning outcomes are strongly and positively correlated [47]. This indicates that when teachers use and navigate the tool easily, they tend to be more efficient, and more productive. Furthermore, Laurencia and Sudarto [48] evaluated the use of MS Teams for online learning during the COVID-19 pandemic. They concluded that when teachers and students rate MS Teams as user-friendly, they also evaluate collaboration, knowledge sharing, and learning outcomes more favorably. Likewise, a study that examined online English teaching and learning with MS Teams suggested that the link between technology usability and team effectiveness is statistically supported [49].

4.2. The Direct Link between the Usability of MS Teams and Intergroup Relation

The results show also that the path coefficient of the effect of MS Teams usability on intergroup relations is 0.569. This shows that the link among the various participant groups within the BENEFIT project will experience a positive increase when they use MS Teams extensively. Furthermore, the results of the hypothesis testing in the research designate that the *p*-value for the relationship between the usability of MS Teams and intergroup relations is 0.001, which is less than the significance threshold of 0.05. This suggests that the usability of MS Teams exercises a statistically significant influence on intergroup relations. Consequently, if there is an increase in the level of communication among the universal BENEFIT groups, it can be inferred from the research results that H2, which posits that usability of MS Teams has a positive and significant effect on intergroup relations, is accepted. This result is in line with the findings of Blanchard [15], who studied the impact of COVID-19 on virtual online group work. The study revealed that frequent use of collaboration and communication tools led to higher intergroup communication and collaboration especially in virtual teams, which in turn increased the intergroup relations. Consequently, the study suggested that increased usability of communication tools led to improved intergroup cooperation and more dynamic interdepartmental interactions.

4.3. The Direct Link between Intergroup Relation and Team Effectiveness

The results show further that the path coefficient of the link between intergroup relations and team effectiveness is 0.486. This means that the effectiveness of BENEFIT teams will practice a higher level of relations with their partners from different universities around the world. Hypothesis testing reveals that the *p*-value for the link between intergroup relations and team effectiveness is 0.001, which is less than the significance threshold of 0.05.

This means that communication among groups has a statistically significant effect on team effectiveness. Consequently, when an improvement occurs in the level of communication within the BENEFIT community, the overall effectiveness of the project team would improve remarkably. Thus, H3 is accepted. This corroborates previous empirical research. For instance, a study by Freitag and Hofstetter [50] during the pandemic, noted that serious and negative emotions associated with the threat of COVID-19 shaped similar attitudes towards immigrants. Bui et al. [51], in their meta-analysis, highlighted the importance of achieving high levels of communication and diversity in order to increase team performance. To sum up, effective intergroup relations in diverse teams can result in higher levels of team effectiveness [27].

4.4. Usability of MS Teams on Team Effectiveness through Intergroup Relation

The results of indirect effect, as shows in Table 8, reveals that the *p*-value for the relationship between MS Teams usability and team effectiveness through intergroup relations is 0.004, which is less than 0.05. This outcome means that there is a significant indirect effect of the usability of MS Teams on team effectiveness through intergroup relations. Particularly, if the usability of MS Teams within groups and communication with other partner groups is increased, the overall team effectiveness would also increase and reach optimal levels. Thus, H4 is accepted. Additionally, as shown in Table 9, the 95% confidence interval ranged from 0.134 to 0.509. This indicates a statistically significant indirect effect as the confidence interval does not include zero. This means that increasing the usability of MS Teams and fostering a high level of communication among different groups of the project would result in a positive increase in the effectiveness of teams. This result is supported by the findings of other studies. For example, a study in sustainability, by Buchal and Songsore [52], declared that employing MS Teams has led to high level of collaborative knowledge building among members. Moreover, they suggested that the usability of technological communication tools such as MS teams positively affected team performance in online teams. In addition, Hargreaves, et al. [53] found a positive link between the usage of MS Teams during the COVID-19 pandemic and the performance of NHS trust community service in North-West England. Furthermore, recent research studied the factors affecting team effectiveness in hospitals and found that the usage of electronic collaborative tools is a mediator on team effectiveness [54]. Hence, these studies emphasize the importance of usability in collaboration tools such as MS Teams and its impact on intergroup relations within a team, which, in turn, influences overall team effectiveness. As businesses increasingly rely on understanding and improving the usability of such tools, they can have a significant positive effect on team dynamics and effectiveness.

Table 9. Total indirect effect—confidence intervals.

	Original Sample (O)	Sample Mean (M)	2.50%	97.50%
MS team Usability -> Team Effectiveness	0.277	0.295	0.134	0.509

4.5. Research Implications

The link between MS Teams usability and team performance is both direct and indirect. It functions indirectly through intergroup connections, particularly by raising communication levels and giving support and counsel within the BENEFIT community. Intergroup relations have the greatest impact on team effectiveness of any of these criteria. An emphasis on communication technologies such as MS Teams is vital for improving and optimizing team performance within Erasmus+ projects. Project coordinators or other policy entities can hold training workshops to teach participants how to use such technologies successfully, especially in difficult communication conditions such as the COVID-19 pandemic. Furthermore, community building activities targeted at establishing ties among various university groups may considerably improve project teams' overall effectiveness

and efficiency. This might include giving members advice on proven and innovative project management methods that can be employed in their work.

Importantly, educating participants to nurture a desire to learn how to use platforms such as MS Teams and Zoom has the greatest influence on member and intergroup connections. As a result, it is critical to guarantee that there is a perceptible shift in the interactions among members and groups following the training sessions to improve and maximize the usage of MS Teams within project communities. Project managers should focus on enhancing the usability of technologies like MS Teams to improve and maximize the efficacy of Erasmus+ project teams. This may be accomplished by teaching and supporting team members to use these technologies meaningfully. Furthermore, soliciting feedback from members before selecting work tools can be very beneficial for their adoption and willingness to use. Moreover, in order to improve team effectiveness within the project community, the administration should guarantee that the training programs facilitate and cultivate attitude change among participants, encouraging them to engage in high-quality communication with their coworkers. For example, this might entail adapting training to consider team members' cross-cultural experiences, as well as offering resources and guidance that can meet particular requirements such as working with colleagues from distinct settings marked by acute political or cultural contrasts and conflicts.

5. Conclusions

In the context of this study, it should be emphasized that the BENEFIT project had planned to train Palestinian higher education faculty members in online learning course design and remote teaching. This professional development action was foreseen prior to the pandemic to strengthen the technological and pedagogical capabilities of concerned academic faculty members. Indeed, this procedure has been critical to the overall project's success. As a result, this study was carried out to evaluate the performance of the BENEFIT team while employing MS teams throughout the pandemic. The findings of this study revealed that the usability of MS Teams had actual and positive influence on team performance, intergroup interactions, and team member relationships. However, this study has additional limitations, most notably the small sample size of 52 participants, which is related to the modest size of the project community. As a result, future researchers can improve the study model by increasing the sample size. Such an approach would broaden the scope of research, making it a valuable resource for evaluating international projects within the larger filed of project team management. Furthermore, future research should investigate other moderating factors that were not addressed in this study. For example, characteristics such as cross-cultural communication and corporate culture, which are known as factors impacting team success, might be valuable subjects to investigate.

As a result of the study findings and discussion about the obstacles experienced by Erasmus+ project BENEFIT during the COVID-19 epidemic, numerous practical insights were formulated, which can be valuable for academic institutions and project teams facing comparable challenges. Improving MS Teams usability is related to a favorable and statistically significant influence on team effectiveness. This implies that increasing the usability of MS Teams can lead to an improvement in total team performance. Furthermore, better MS Teams usability has a favorable and statistically significant impact on Member Relations and Intergroup Relations within the project community. This suggests that improving the usability of MS Teams can improve connectivity and communication both between partner groups and among individual group members. Furthermore, greater intergroup relations are favorably and strongly related to the project's team effectiveness. This means that increasing cohesiveness in intergroup interactions might lead to increased team effectiveness. Finally, through its influence on intergroup relations, the usability of MS Teams has a positive and statistically significant effect on team effectiveness. This elucidates the causative link, implying that by strengthening intergroup ties utilizing MS Teams as a facilitation tool, team effectiveness may be improved. In essence, these findings

highlight the possibility of using MS Teams to promote stronger intergroup interactions, which in turn improves overall project team effectiveness.

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Appendix A. Study Questionnaire

5-level Likert scale (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree)

Usability of MS Teams

1. I think that I would like to use MS Teams frequently.
2. I found MS Teams unnecessarily complex.
3. I thought MS Teams was easy to use.
4. I think that I need the support of a technical person to be able to use MS Teams.
5. I found the various functions in MS Teams were well integrated.
6. I thought there was too much inconsistency in MS Teams.
7. I would imagine that most people would learn to use MS Teams very quickly.
8. I found MS Teams very awkward to use.
9. I felt very confident using MS Teams.
10. I needed to learn a lot of things before I could get going with MS Teams.

Intergroup Relations

1. We are able to resolve conflicts with other teams collaboratively.
2. We seek to arrange our priorities to meet the needs of other work groups.
3. We communicate effectively with other groups.
4. Our team has established trusting and supportive relationships with other teams.
5. We work toward integrating our plans with those of other work groups.
6. Our collaborations with other teams are productive, worthwhile, and yield good results.
7. The goals of our group support those of other groups.

Team Effectiveness

1. Our team has a meaningful, shared purpose.
2. We are strongly committed to a shared mission.
3. We focus on big-picture strategic issues as much as on day-to-day activities.
4. We set and meet challenging goals.
5. We consistently produce strong, measurable results.
6. We make sure our work helps the organization achieve its goals.
7. The mission and goals of my team are well aligned with the organization's mission and goals.

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Perspective of education in Agriculture 4.0 in selected countries in European Union and Palestine

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***Abstract*— To achieve the aim to foster competitive and sustainable agriculture and forestry sector that "achieves more from less" - which is the one of the main aims of the precision farming - is necessary to bring together innovation actors (farmers, advisors, researchers, businesses, NGOs, etc.) and help to build bridges between research and practice, thus positioning at the core of the innovations in agriculture. Precision Agriculture is an innovative concept, not specifically about the technologies, but about the overall concept putting the accent on understanding how the technologies can make farming more accurate and controlled. The research, presented in this article, has been done in the framework of the BENEFIT project (609544-EPP-1-2019-1-PS-EPPKA-CBHE-JP) which runs under the Erasmus+ Capacity Building for Higher Education program and its innovative character serves not only the capacity-building aspect for Palestinian universities, but also addresses the challenges faced by Palestine regarding the integration of the newest (digital) technologies into agriculture and rural development.**
The article presents perspectives of education in Precision Agriculture and Agriculture 4.0 in selected countries in the European Union - Slovakia, Czech Republic, and Palestine.

Keywords*— *component, formatting, style, styling, insert precision agriculture, digitalization, rural areas, Palestine, BENEFIT project

I. INTRODUCTION

The agriculture sector in Palestine carries both economic and political importance. According to the Palestinian Central Bureau of Statistics [1], this sector is employed about 11,5% of the labour force. Further, the agriculture income represents 5,6% of the gross domestic product (GDP) and accounts for 21% of the total exports. More notably, the agriculture in Palestine plays a central role in land protection from Israeli confiscation and settlements. Thus, the vision of the agriculture strategy “resilience and development” announced by ministry of agriculture (2017-2022), to be achieved during the coming years: to have a sustainable and feasible agriculture sector that can compete domestically and externally; and can effectively contribute to enhancing food security and the connection between the Palestinian people and their land, while also enhancing Palestinian state-building efforts through resource sovereignty.

The environmental and political challenges are the main factors threaten the agriculture sector in Palestine. However, the effects of these issues are more intensified when considered in the frame of Climate Change [3]. In this perspective, water quantity and quality have been continuously declining during the last years. Further, the scarcity of land resources, rapid population growth, pollution of the aquifers and marine environment, desertification and land degradation are challenging. Under the regional climate changes such as changes in

precipitation quantity, rain distribution, and the increases in seasonal temperature variability the environmental problems more intensified. Consequently, negative impact on agriculture sector my realized attributed to damage crops, decrease water availability, loss of biodiversity. Thus, can negatively affect the natural control of agricultural pests, and delay the growing seasons.

Generally, the industrial and/or digital technologies are expanding in global phenomenon with an emphasis on digitalisation, automation, control and robotics in various operations, related to environmental protection, soil cultivation management, optimization of crops nutrition, crop tending, etc. [2]. The added value of automated robotic systems to agriculture is the enhancement of their flexibility, concerning farmer decision making to select the optimal technological arrangements during the production process of the field crops, which entails not only economic but also environmental and social aspects [5]. As a result, the use of (digital) technologies could allow the agricultural sector to achieve big leaps in Palestine, especially in improving environmental protection, increasing productivity, and introducing the cultivation of new strategic classes of crops. The knowledge about advanced agricultural technologies have therefore become key for the farmers in these regions, throughout the process of cultivation and harvest.

"Precision agriculture", also called "digital farming", is an innovative concept in the countries of Middle East and especially in Palestine. This is not specifically about the technologies, but about the overall concept putting accent on understanding how the technologies can make the farming more accurate and controlled.

In the document "National Agricultural Sector Strategy (2017-2022) "Resilience and Sustainable Development" [4] as one of the main factors that had negative impact on (sustainable) agriculture development weak capacity to keep up with technological progress, low competitiveness of local products and abandoning production processes have been identified. As a possible solution of this problems the following two actions have been proposed:

1. Working with the private sector to keep abreast of new technologies and encouraging their entry into the local market and
2. Continuous training of human resources in the agricultural sector to keep abreast of technical agricultural progress.

From these points of view, the innovative character of the BENEFIT project serves not only the capacity-building aspect for Palestinian universities, but also addresses the challenges faced by the Palestine regarding information and communication technologies (ICT), technological developments, and creating a global education and research framework for innovation and development regarding the integration of newest (digital) technologies into agriculture and rural development.

II. MATERIALS AND METHODS

The BENEFIT project activities are based on the following main steps of the methodology:

- capacity-building of the team;
- the development and implementation process;
- the establishment of a platform for digital agriculture and piloting and
- conducting initially a short-term change inside the Palestinian universities and follow up with a long-term and a sustainable change.

Specifically:

A. Capacity Building & Training

The academics training covers topics related to the instructional design framework of the project, based on the TPACK Instructional Design Model, Bologna principles, ECTS system, scientific publication and first of all precision farming like GPS guidance, control systems, sensors, robotics, drones, autonomous vehicles, variable rate technology, GPS-based soil sampling, automated hardware, telematics, and software which assists the team to design and develop curriculum and courses' syllabuses proposed for each Palestinian universities focusing on one of the following areas:

- Digital Farming and Precision Agriculture
- Smart irrigation and fertilization
- Mechatronics in agriculture
- Automated control systems in agriculture production

This starts on the alligment of the used pedagogy (pedagogical knowledge) with the courses content (content knowledge) and the state of the art technology (Technological Knowledge). Continusly, the pre-produced curricula and syllabus for each Palestinian University is following, as well as the accreditation of the updadet on new-developed courses. This stage aims to define all the educational aspects of the new courses like core aim, main targets, learning objectives and outcomes.

Activities related to this phase are the following:

- characteristics, needs and desires of learners (diagnostic assessment-needs analysis)
- identification of the issues/problems/needs (needs assessment for problem solving)
- identification of the theories and methods to accomplish intended outcomes,
- definition of short-term and long-term changes intended for learners,
- identification of the evaluation strategies for used methodology, developed content, and intended outcomes.

The output of this sub-phase is the redaction of Terms of Reference (Benefit ToR) that were produced. It serves as training blueprint to develop or enhance course or study program and enrich the learning, research and teaching process inside Palestinian Universities, focusing on precision agriculture in local communities. The main target is the better consideration of local, regional and national authorities and the potential implementation of concreate modern and open technologies and resources in agriculture as a stimulus at development of Palestinian economy and improving job creation.

B. Development, Implementation and Deployment

Based on the output of previous phase - Terms of Reference - each Palestinian's partner develops of their own Curricula and Syllabus.

The process contents following activities:

- Technology, Content and Pedagogy alligment;
- Identify Issues/Problems/Desires/Needs;
- Conduct Needs Assessment and Analysis;
- Refine and restate the issue, if needed, and develop the intended outcomes and educational objectives;
- Select Meaningful Content;
- Design Experiential and state of the art Methods;
- Produce a qualitative and anhancing Curriculum.

C. Infrastructure and deployment

This phase plans the installation process for the whole equipment's related to pilot site for digital agriculture and piloting, including equipment's installation, deployment and testing equipment's.

III. RESULT AND DISCUSSIONS

Capacity building for Palestinians professional development is the main axis of the BENEFIT project that gives the Palestinian higher education institutions and their staff a great opportunity to gain more expertise and develop their academic, research, and technical staff by opening new knowledge and scientific research.

In the beginning, the BENEFIT project focused on the Capacity Building and transfer of knowledge-under an interactive process- from the EU to Palestine academic sector and Palestinians' academic training. These activities mainly focused on the training workshops and covered topics related to the most synchronous methodologies, the most constructivist pedagogies and emerging technologies, like precision farming, GPS guidance, control systems, sensors, robotics, drones, autonomous vehicles, variable rate technology, GPS-based soil sampling, automated hardware, telematics, and software and their possible application in agriculture processes. The obtained knowledge assisted the teams to design and develop the curriculum and courses' syllabuses proposed for each Palestinian university.

To reach as much as efficient and effective results of training, all Palestine's teams realized Institutional Readiness Surveys, where defined all the educational aspects of the accreditation processes, core aims of the courses, main targets, learning objectives, outcomes, the responsible infrastructure of laboratories, etc.

Activities related to this phase were twofold:

- **Institution Readiness Level survey**, which explored the 'readiness' of the Palestine's partners as it relates to the adoption the knowledge transfer from the EU partners and the development of innovative courses in precision agriculture and identified the issues/problems/needs of each PS partner.
- **The Term of References design**, which defines the meaningful alignment of content, the pedagogy and the used technology, any characteristics, needs, and desires of learners, identifies the theories and methods to accomplish intended outcomes, defines the short-term and long-term changes intended for learners, and identifies the evaluation strategies for used methodology, developed content, and intended outcomes.

A. Institution Readiness Level Survey

The survey was realized in the period March 2020 – June 2020 and following universities were involved:

- An-Najah National University (ANNU, www.najah.edu),
- AL-ISTIQLAL UNIVERSITY (PASS, www.alistiqlal.edu.ps),
- Palestine Technical University-Kadoorie (PTUK, www.ptuk.edu.ps),
- Al- Quds Open University (QOU, www.qou.edu)
- Hebron University (HU, www.hebron.edu),
- University College of Applied Sciences (UCAS, www.newucas.ucas.edu.ps).

The Fig. 1 and Fig. 2 present basic information about the academic staff and students. Fig. 3 shows the situation with the number and levels of study programs offered by each university.

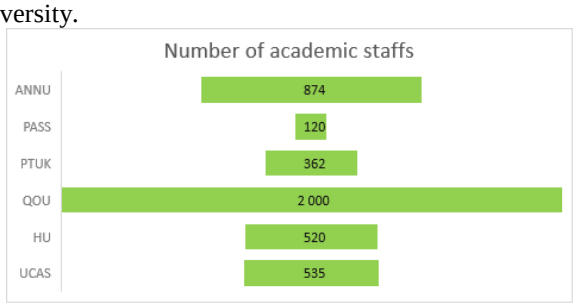

Fig. 1. Number of academic staffs

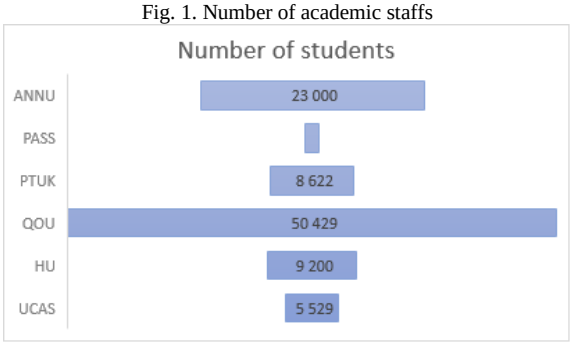

Fig. 2. Number of academic staffs

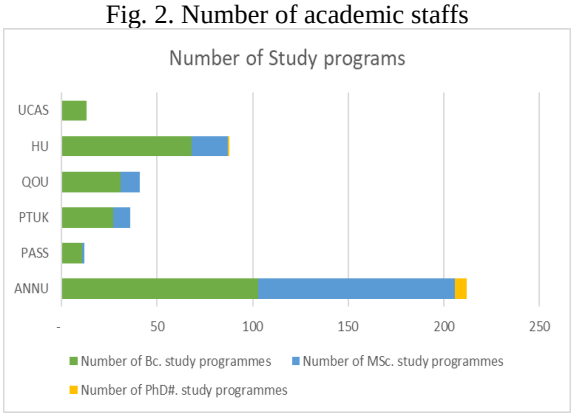

Fig. 3. Number of Study programs

The first part of the survey focused on the ECTS and Bologna principles implementation in the Palestine. We asked for following questions:

- Do you follow Bc./MSc./PhD. organisation of the high education?

- Is there a national agency which recognizes and monitors the implementation of ECTS and Bologna principles (or equivalent)?
- When a Bc./MSc/PhD. cycle is considered completed at your university
- How do you measure student's workload at your university?
- List the criteria that are baseline for the measure of students' workload.
- Do you use catalogue of subjects? How is it organized?
- Describe the process of recognition students' knowledge.
- Describe the evaluation criteria for students gaining knowledge.
- Do you think that the programmes of studies at your institution/university are mostly "Student-oriented" or "teacher-oriented"?

The main findings of the survey are the following: All universities follow three levels' tertiary education format. In Palestine exists AQAC - The Accreditation and Quality Assurance Commission, part of the Ministry of higher education. Each study program (a Bc/MSc/PhD.) has an assigned number of credit hours and each high education institution has its specific credit hours in a study plan. The enrolled students in these programs should complete the programs' credit hours successfully to earn the program's degree. It is worth knowing that each program has its own methods of evaluation including in its course syllabus.

The assessment of the student's workflow is mainly based on the grades of final or mid-term exams, seminar presentations, reports on special topics, and laboratory reports.

The second part of the survey focuses on research & development activities and the following centres of excellence have been identified:

- At ANNU Agricultural Research and Training Centre activities are oriented on applied research in plant and animal production.
- At PASS Date palm research centre focuses on water management, plant protection, tissue culture and soil protection related to the growing of date palms.
- At PTUK Innovation and Education Technology Center (IETC) activities focus on fostering entrepreneurship among students and enable them to transfer their innovative ideas into real business through training, consultation, networking and providing fund to build their projects' prototypes or to establish their own startup.
- At HU Excellence Center provides plant production and protection research.
- At UCAS UCIBD: UCAS Centre of Innovation and Business Development.

B. The Term of References design

The BENEFIT Term of Reference (BENEFIT ToR) defines the purpose and the structure of the courses developed and the shared goal of the stakeholders, who have agreed to work together to accomplish that goal. The Terms of Reference of the project provide developers with clear instructions for the pedagogy, the technology and the content was used for syllabus of the curriculum design. It provides the structure and methodology that is the most effective for BENEFIT Course(s) Syllabus and integrates three topics:

- BENEFIT instructional design and excellence framework,
- BENEFIT course syllabus,
- BENEFIT accreditation process.

Following paragraphs present the ToRs for a course developed under the BENEFIT project and as a result of Institution Readiness Level Surveys.

ANNU BENEFIT Term of References

The "Protected Agriculture Management" course is a 4-credits course that gives students both theoretical and practical skills knowledge in a variety of concepts and techniques on protected agriculture management. Students will gain the required skills that are essential to the importance and types of protected farming; greenhouse design, components, and installation; and agricultural processes and their effect on increasing agricultural productivity and improving quality of the product inside these houses by using high tech.

The main objectives for this course are defined as follows:

- Get to know the various means of protection and types of covering materials.
- To acquire the necessary knowledge about controlling environmental factors under protective structures.
- To grow and manage the production of some crops grown under protected structures, e.g. tomato, cucumber, pepper, kidney bean, and lettuce with emphasis on up-to-date technology.
- To study in-depth, the soilless cultivation techniques.

Upon successful completion of this course, students should be able to:

- Identify facilities used in protected agriculture.
- Differentiate the functions of the facilities used in protected agriculture.
- Manage the production under protective structures.
- Operate successfully with new technology involved in protective structures.
- Develop a proposal for industry-based problems
- Demonstrate ability to work effectively with a team within predefined time constraints.
- Develop suitable documentation and reports with a high level of detail and clarity.
- Evaluate and justify the main outcomes of the project.

PASS BENEFIT Term of References

The course Food Security/Quality examines precision agriculture and food security/quality in the historic, modern and post-modern eras. Case studies are drawn from Palestine and international contexts to examine humanity's changing relationship with production, supply chain, ecological, economic, and socio-cultural systems fundamental to the provision of food. The types of issues that are introduced include pre-modern or traditional agriculture; the origin and development of agricultural biodiversity; the relationship between food supply and cultural identity; modernization; new technological

development and application; smart agriculture and food security; the political-ecologies of agriculture; environmental management; the emerging alternative roles of agriculture to food production; and the future roles of alternative systems based on diversity and location.

Upon successful completion of this course students will be able:

- To address the vital issue of food security/quality in an interdisciplinary and hands-on fashion.
- To offer interdisciplinary food security/quality education in the region.
- To have knowledge and understanding of the content and techniques of food security/quality at advanced levels that are internationally recognized.
- To locate, analyze, evaluate, and synthesize information from a wide variety of sources.
- To apply practical, creative, and innovative solutions, both independently and cooperatively, to current and future problems.
- To understand proficiency in the appropriate use of contemporary technologies.

PTUK BENEFIT Term of References

Precision agriculture has been incorporated in some parts of the existing courses as modules:

- Module 1: Design of Irrigation and Drainage (water flow in pipelines and open channels, programming and management of irrigation water, and irrigation scheduling),
- Module 2: Soil Chemistry and Physics (the perspective of soil chemistry and physics, data from multiple sources such as nutrient sensors, soil moisture and temperature will be used as new technologies for assist physical properties of soil, and the data of nutrient sensors will be used to assess the soil quality in term of soil water plant relationship and optimizing soil management),
- Module 3: Soil Fertility and Fertilizers (soil nutrients reaction and transformation, soil nutrients evaluation, methods of fertilizers application and fertilizer programing),
- Module 4: Agricultural Economics (Big data management and analysis, economic analysis, fundamental to the precision agriculture, adaptation and technology transfer methodologies),
- Module 5: Introduction to Animal Science (principles of precision agriculture in the crop and livestock production, data acquisition and management, the application of the sensor in poultry farm and in the cultivation of the hydroponic barely),
- Module 6: Plant physiology (the precision agriculture based on crop physiological principles, underlying the relationship between environmental factors and crop growth and development and yield, in order to optimize growth environment for plant production).

Upon successful completion of this course students will be able:

- To understand the principles of water flow in pipeline and open canals and management of the drip and sprinkler irrigation systems at farm level.
- To understand how to evaluate soil fertility based on observation, soil chemical testing.
- To estimate the soil physical and chemical properties that affect the availability of nutrients in the soil, and how to consider these properties for optimizing fertilizer management.
- To understand the relationship between soil properties and water and how to take soil samples and compare the label analysis with field analysis that measure sensors in term of moisture content and nutrient availability.
- To learn how to manage, analyze, and interpret big data and to clarify data risk management through backup systems and safety regulation tools.
- To understand the principles of precision agriculture topics in livestock, installing and using the sensor in the poultry farms, the cultivation of hydroponic barrels.
- To identify the physiological processes in relation to plant growth and yield, the various methods for measuring plant physiological parameters, and to understand the influence of environmental factors on crop growth and development.

HU BENEFIT Term of References

The agriculture sector in Palestine is mainly depending on producing fruits and vegetables. The Palestinian farmers have been for long time are using the traditional methods for planting these crops. The need for developing the ways of planting fruits trees is very important in increasing the production and decreasing the costs so making the farmers getting more profits.

The college of agriculture in HU is aware of this and it teaches the students who will become the agricultural extension agents this course, which introduce the techniques of fruit production so the farmers of fruit and vegetable producers will benefit from these techniques and increase their revenues.

The course Fruit Trees Production covers the economic importance of fruit trees and the reality of its production globally and locally. The basic information's necessary to produce both types of fruit trees; deciduous and evergreen, including stone fruits, pome fruits, nuts, citrus, olives, bananas, grapes, figs. It also includes new rootstocks and cultivars, training and pruning methods, pollination and flowering, indices of maturity, in addition to environmental requirements.

This course covers the economic importance of fruit trees and the reality of its production globally and locally, the basic information's necessary to produce both types of fruit trees; deciduous and evergreen, including stone fruits, pome fruits, nuts, citrus, olives, bananas, grapes, figs. and includes new rootstocks and cultivars, training and pruning methods, pollination and flowering, indices of maturity, in addition to environmental requirements.

The main objectives for this course are defined as follows:

- To understand the importance of fruit trees and its nutritive value.
- Knowing the management practices of the orchard.
- Studying the effects of environmental conditions on fruit trees growth, flowering, fruit set, and harvesting.

Successful completion of the course should lead to the following outcomes:

- Identifying different types of fruit crops, which can be successfully grown locally.
- Students will be introduced to different aspects of fruit culture such as physiology of plant growth and development.
- Students will learn how cultural practices can be used to manipulate growth and development and optimize fruit yield and quality.
- Focus on the best management conditions and practices for fruit.
- Describing the general background requirements needed to grow a wide variety of fruit crops.

UCAS BENEFIT Term of References

The major of agricultural engineers' assistants aims to prepare a cadre of agricultural technicians who can deal independently with personal and work-related challenges so that they have the ability to find suitable solutions to the problems that the agricultural sector might face in both fields plant and animal in which achieve the requirements of the labor market and achieve the necessary qualifications in order to develop the agricultural sector and achieve the sustainable development.

The course Irrigation and Fertilization aims to raise students' ability to collect information about the types of fertilizers available in the market and the percentage of elements in them, as well as methods for preparing nutrient solutions, In addition to learning about the fertigation system in relation to its operation and maintenance method and its use in conventional and isolated agriculture as well as helping students on how to diagnose the symptoms of deficiency of elements, design schedules for fertilizing crops and preparing work reports.

The main objectives for this course are defined as follows:

- Determine the types of agricultural fertilizers in the market and know their chemical compositions.
- The ability to implement and apply fertilization programs that were previously designed according to the fertilizer needs of the crop.
- The ability to diagnose pathological injuries related to deficiency of elements.
- Estimating the water requirements of agricultural crops.
- Implementation of safety measures and environmental protection.
- Use of agricultural fertilizers according to the needs of the plant and based on the symptoms of deficiency that have been diagnosed.
- Apply the best use of water during irrigation of crops.

CONCLUSION

The agriculture sector in Palestine carries both economic and political importance. The vision of the agriculture strategy "resilience and development" announced by the Ministry of agriculture focus emphasis on a sustainable and feasible agriculture sector that can compete domestically and externally; and can effectively contribute to enhancing food security and the connection between the Palestinian people and their land, while also enhancing Palestinian state-building efforts through resource sovereignty.

The article presents the results of the BENEFIT project (609544-EPP-1-2019-1-PS-EPPKA-CBHE-JP) which runs under the Erasmus+ Capacity Building for Higher Education program. The activities of the projects focus on precision farming, an innovative concept in the countries of the Middle East and especially in Palestine. This is not specifically about the technologies, but about the overall concept putting the accent on understanding how the technologies can make farming more accurate and controlled.

The BENEFIT project focuses not only on the capacity-building aspect for Palestinian universities, but also addresses the challenges faced by Palestine regarding ICT, technological developments, and creating a global education and research framework for innovation and development regarding the integration of the newest (digital) technologies into agriculture and rural development.

At last, but not least, cooperation between EU and Palestine universities contributes to multicultural mating and collaboration.

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STUDENT'S AWARENESS, KNOWLEDGE, AND PERCEPTIONS OF PRECISION AGRICULTURE TECHNOLOGY IN PALESTINIAN AGRICULTURAL FACULTIES

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ABSTRACT: *Precision agriculture (PA), which uses satellite navigation, has emerged to help increase crop yields and improve efficiency. Despite the increase in the body of PA literature, little is known about PA in Palestine. This research aimed to analyze university students' awareness, knowledge, and perceptions towards PA. An item-based questionnaire was designed and distributed online to agriculture college students in Palestine. It was found that, among students (n = 211), the majority had moderate, low, and very low level of knowledge and awareness (85%) of PA. While the majority of students (77%) had either strongly agree, agree, and neutral for perceptions toward PA. Generally, the stand of students for PA is positive and there is a strong believe among them that universities have a significant contribution to introduce PA into Palestine, and most students were with the need to develop new courses of PA in Palestine. In addition, there was a significant difference between the five universities' students and study level; further research should focus on analyzing.*

KEYWORDS*: Precision Agriculture; Smart Farming; Education; Internet of Things; Drones*

1 INTRODUCTION

In developed countries, agriculture practices have a tendency to support better energy inputs using machines and intensified use of pesticides and fertilizers. Whereas such intensive agricultural activities have negative environmental, health and economic consequences such as soil pollution, soil fertility deterioration, groundwater water contamination, eutrophication, well as build-up of chemical residues in the fruit crops, as well as increase agricultural input costs, which in turn impacts the sustainable agriculture in negative manner (Folhes et al., 2009; Allahyari et al., 2016). There is an urgent and serious need for shifting to a new production technique that protects the environment, enhances human health and is more sustainable for the new generations. Around the world, PA is substituting the method of how people are used to grow their crops and manage their herds and even after they produce their agricultural products as it offers a multitude of possible gains in cost-effectiveness, yield, sustainable production, environment protection, and rural development. (Liaghat and Balasundram, 2010; Schimmelpfennig, 2018).

PA is a technology-based agricultural system, created to enhance the agricultural practices by accurate monitoring of every step to guarantee reaching higher production with reduced effect on the environment, human health, taking into account the profitability of the farmers. PA focuses on delivering the best way for detection, evaluation and regulating agricultural activities. It deals with a wide range of agricultural issues such as herd management and the agricultural production cycle

(Burrell et al., 2004; Zhang et al., 2004; Thompson et al., 2019). PA includes the regulation of cultivation practices, adjusting the fertilization programming and application and accurate application of irrigation water and irrigation scheduling (Adams et al., 2000).

To achieve this, innovative trends have been developed within the agricultural sector. Appreciations to the improvements in the area of wireless sensor networks as well as the reduction of the size of sensor motherboards, PA kicked off. Several technologies were utilized to produce safer agricultural products and to decrease their unfavorable effects on the environment, an objective that is considered to be in harmony with sustainable agriculture. PA came out as an appreciated module of this structure to accomplish that objective (Liaghat and Balasundram, 2010; Chuang et al., 2020).

As shown in the reports of the Palestinian Ministry of Agriculture (MoA), there are quite a lot of difficulties and challenges to the Palestinian agricultural sector. One of these important challenges is the limitation in the availability of agricultural land, which makes the shifting to a more efficient agriculture a necessity and priority. The second important challenge is the limitation in the availability of freshwater. It should be pointed out that a high percentage of Palestinian farmers use drip irrigation systems to irrigate their fields (MoA, 2014). However, the majority of Palestinian farming system is a traditional system carried out without well prepared plans and without using modern or evolved equipment; which is because of the absence of financial support and training or both. Finally, the number of agronomists is inadequate; this delays the progress in this sector and restricts the use of such advanced technologies in the sector. In addition, local farmers are not well prepared to deal with modern technologies and prefer conventional systems (Abdalla et al., 2019; MoA, 2014). At the same time PA or smart farming are not included in the curricula of the faculties of agriculture in Palestine (Deans of faculties of agriculture in Palestine, personal communication).

Under these circumstances, the employment of advanced technology in the Palestinian agricultural system will have a positive impact. It will lead to improved productivity either by increasing the production quantitatively or qualitatively (Abdalla et al., 2019; MoA, 2014).

Using PA in education in Palestine is still limited. A team of researchers from several Palestinian and European universities, including the authors of this study, participants to the Erasmus+ project entitled “Boosting Innovation in Education and Research of PA in Palestine/ BENEFIT”, (609544-EPP-1-2019-1-PS-EPPKA-CBHE-JP), has developed a framework for using PA technology to teach several courses, in all Palestinian agricultural colleges. Through published scientific papers, the team presents perspectives of education in PA and agriculture 4.0 in selected countries in the European Union - Slovakia, Czech Republic, and Palestine (Palková et al., 2021; Palková et al., 2022).

The aim of this study was to identify the level of awareness, knowledge, and perceptions toward PA from the perspective of the students of agricultural colleges’ students in Palestine.

2 MATERIALS AND METHODS

2.1 Study Population, Design and Sampling

To perform our study, it was necessary to propose some hypotheses. The tested hypotheses were as follows:

1. Knowledge Level by Gender:

- Null Hypothesis (H0): There is no significant difference in the knowledge of precision agriculture between male and female Palestinian university students enrolled in agriculture programs.
- Alternative Hypothesis (H1): There is a significant difference in the knowledge of precision agriculture between male and female Palestinian university students enrolled in agriculture programs.

2. Knowledge Level by Academic Level:

- Null Hypothesis (H0): There is no significant difference in the knowledge of precision agriculture among Palestinian university students in different academic levels (third grade, fourth grade, or masters) enrolled in agriculture programs.
- Alternative Hypothesis (H2): There is a significant difference in the knowledge of precision agriculture among Palestinian university students in different academic levels (third grade, fourth grade, or masters) enrolled in agriculture programs.

3. Perception by Academic Level:

- Null Hypothesis (H0): There is no significant difference in the perception of the need for a precision agriculture curriculum among Palestinian university students in different academic levels (third grade, fourth grade, or masters) enrolled in agriculture programs.
- Alternative Hypothesis (H3): There is a significant difference in the perception of the need for a precision agriculture curriculum among Palestinian university students in different academic levels (third grade, fourth grade, or masters) enrolled in agriculture programs.

4. Knowledge Level by University:

- Null Hypothesis (H0): There is no significant difference in the knowledge of precision agriculture among Palestinian university students enrolled in agriculture programs at different universities.
- Alternative Hypothesis (H4): There is a significant difference in the knowledge of precision agriculture among Palestinian university students enrolled in agriculture programs at different universities.

5. Perception by University:

- Null Hypothesis (H0): There is no significant difference in the perception of the need for a precision agriculture curriculum among Palestinian university students enrolled in agriculture programs at different universities.
- Alternative Hypothesis (H5): There is a significant difference in the perception of the need for a precision agriculture curriculum among Palestinian university students enrolled in agriculture programs at different universities.

The Table 1 shows the demographic characteristics of Palestinian students used for the study.

Table 1. Demographic Characteristics of Palestinian Students (N = 211)

	f	%
Gender		
Female	112	53.1%
Male	99	46.9%
University		
ANNU	57	27.0%
PTUK	29	13.7%
HU	38	18.0%
AUG	56	26.5%
QOU	31	14.7%
Academic Level		
Third grade	80	37.9%
Fourth grade	99	46.9%
Master	32	15.2%

In a sample of 211 Palestinian students, the distribution of gender revealed that females comprised a slight majority with 53.1% students (*N* = 112), while males accounted for 46.9% students (*N* = 99). When examining the university affiliations, students were primarily from ANNU (*N* = 57, 27.0%), followed by AUG (*N* = 56, 26.5%), HU (*N* = 38, 18.0%), QOU (*N* = 31, 14.7%), and PTUK (*N* = 29, 13.7%). The academic level of participants varied, with fourth-grade students representing the largest group (*N* = 99, 46.9%), third-grade students (*N* = 80, 37.9%), and master's students (*N* = 32, 15.2%). The graphical distribution is shown in Figures 1-3.

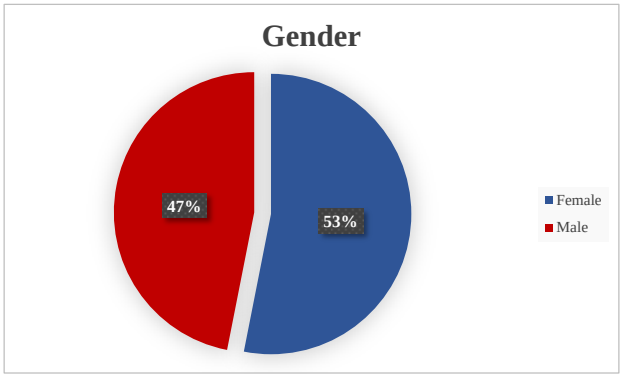

Fig. 1 Pie chart showing gender distribution of Palestinian students in the sample.

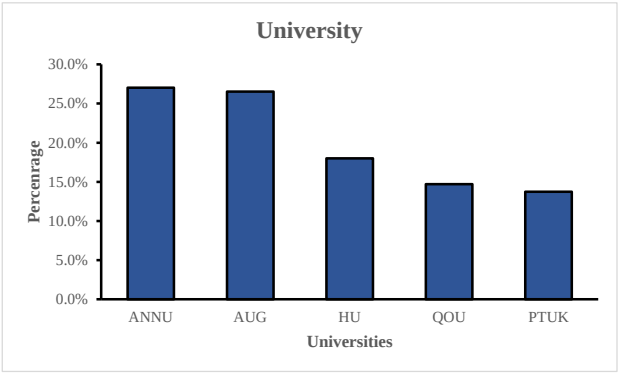

Fig. 2 Bar graph showing the distribution of Palestinian students across different universities.

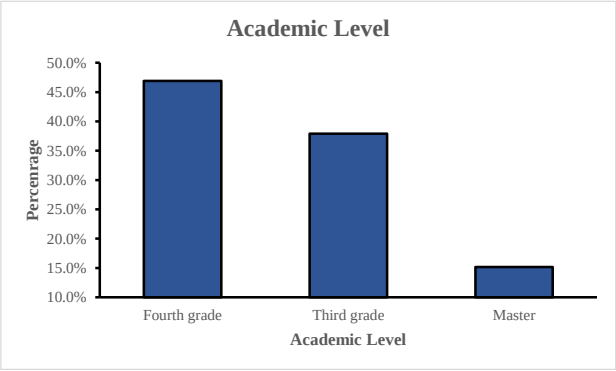

Fig. 3 Bar graph showing distribution of Palestinian students across three different academic levels.

Table 2 presents the descriptive statistics for the ten survey questions used to measure Palestinian university students' perceptions of precision agriculture. All questions were measured on a five-point Likert scale, with 1 indicating "Strongly Disagree" and 5 indicating "Strongly Agree."

The results revealed variations in student perceptions across different aspects of precision agriculture. Questions concerning the need for curriculum development received the highest mean scores. Students displayed the strongest agreement with the statement "I believe that there is a need to develop some of the current study courses to include PA applications" (M = 4.42, SD = 0.66), followed by "I believe that there is a need to develop new courses of study on PA within my field of specialization" (M = 4.39, SD = 0.77). These findings suggest a general student desire for increased integration of precision agriculture concepts into their existing coursework.

Conversely, the lowest mean scores were associated with questions regarding the current availability of infrastructure and training opportunities. Students expressed the least agreement with the statements "I think the infrastructure for PA is available in my department and university" (M = 2.81, SD = 1.03) and "Training opportunities on PA and its applications are available" (M = 2.82, SD = 1.05). These results suggest that students perceive a lack of readily accessible resources for learning about and implementing precision agriculture practices.

The table further shows the skewness and kurtosis values for each question. Skewness ranged from -1.30 to 0.42, indicating that the data distribution for most questions was relatively symmetrical.

Table 2. Descriptive Statistics of Student Perceptions on Precision Agriculture (N = 211)

	Mean	SD	Min	Max	Skewness	K
Training opportunities on PA and its applications are available	2.82	1.05	1	5	0.42	
Find different information sources to develop my knowledge about PA and its applications	3.85	0.85	1	5	-0.65	
Interested in knowing appropriate solutions provided by PA to the problems of agriculture within the local environment	3.96	0.78	2	5	-0.53	
I believe that there is a need to develop new courses of study on PA within my field of specialization	4.39	0.77	1	5	-1.30	
I believe that there is a need to develop some of the current study courses to include PA applications	4.42	0.66	3	5	-0.71	
I think the infrastructure for PA is available in my department and university	2.81	1.03	1	5	0.11	
I think that PA is far from being applied in my field of specialization.	3.11	1.22	1	5	-0.15	
I am thinking of doing a graduation project in the framework of PA	3.30	1.01	1	5	0.03	
I think that the general environment of the Palestinian reality constitutes a suitable incubator for PA	3.30	0.93	1	5	-0.18	
I believe that PA is the future of agriculture inevitably	4.09	0.81	2	5	-0.43	

The mean scores of the ten-question measuring perception of Palestinian students on precision agriculture is shown in Figure 4.

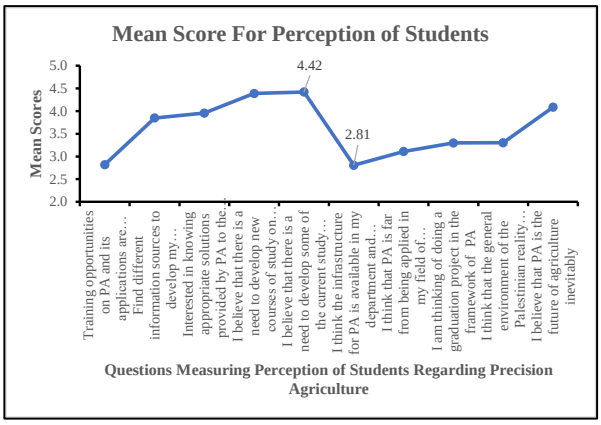

Fig 4. Line graph showing mean scores of the ten-question measuring perception of Palestinian students on precision agriculture

Table 3. Descriptive Statistics of Student Knowledge and Skills on Precision Agriculture (N = 211)

	Mean	SD	Min	Max	Skewness	Kurtosis
How familiar are you with smart farms?	2.68	0.86	1	5	0.06	0.31
How familiar are you with the use of smart farming automated control system?	2.52	0.89	1	5	0.35	0.02
How familiar are you with the use of GPS guidance systems in smart agriculture?	2.41	0.94	1	5	0.64	0.41
How familiar are you with the use of electronic applications (Apps) in smart agriculture?	2.45	0.97	1	5	0.48	0.20
How familiar are you with the use of Big Data technology in smart agriculture?	2.19	0.88	1	5	0.64	0.45
How familiar are you with the use of image recognition technology in smart agriculture?	2.51	0.93	1	5	0.46	0.22
How familiar are you with the applications of sensors and monitoring in smart agriculture?	2.52	0.93	1	5	0.15	-0.40
How familiar are you with the application of wireless sensor networks in precision agriculture?	2.28	0.91	1	5	0.53	0.08
How well do you know how to use robotic in smart agriculture?	2.16	0.85	1	4	0.20	-0.72
How familiar are you with the use of drones in smart agriculture?	2.15	0.86	1	5	0.34	-0.32
How familiar are you with using the Internet of Things (IoT) in smart agriculture?	2.24	0.95	1	5	0.67	0.33
How familiar are you with the applications of smart systems in the management of livestock farms?	2.39	0.97	1	5	0.43	0.01
How much do you know about spectroscopy and computer vision in growing crops?	2.06	0.83	1	5	0.69	0.93
How familiar are you with the applications of measuring temperature, humidity, and wind speed (Meteorological Data)?	2.62	1.05	1	5	0.20	-0.54
How much do you know the scientific knowledge that makes me able to understand and work with smart farming techniques?	2.52	0.99	1	5	0.36	-0.18
How much do you know about Climate Smart Agriculture and how it differs from Smart Agriculture?	2.27	0.87	1	5	0.21	-0.19
How familiar are you with the programming of smart farming techniques?	2.19	0.86	1	4	0.36	-0.46
How well do you know that you possess the scientific knowledge and skills that make you able to work as a mentor in the field of smart agriculture?	2.44	0.97	1	5	0.33	-0.21
knowledge and skills to work as a representative for a company marketing SAT	2.50	1.06	1	5	0.42	-0.18

Table 3 presents the descriptive statistics for the nineteen survey questions used to measure Palestinian university students' knowledge and skills related to precision agriculture. All questions were measured on a five-point Likert scale, ranging from 1 ("Very Low") to 5 ("Very High").

The results revealed a mixed picture of student knowledge and skills in various precision agriculture domains. While some questions showed a basic level of familiarity, others indicated a need for improvement. Students demonstrated the highest average familiarity with "smart farms" (M = 2.68, SD = 0.86), followed by "applications of measuring temperature, humidity, and wind speed (Meteorological Data)" (M = 2.62, SD = 1.05). These scores, however, fall between "Low" and "Average" on the Likert scale, suggesting a need for improvement in foundational knowledge of these core precision agriculture aspects.

Conversely, student responses indicated the lowest familiarity with "spectroscopy and computer vision in growing crops" (M = 2.06, SD = 0.83) and "use of drones in smart agriculture" (M = 2.15, SD = 0.86). These findings suggest a potential knowledge gap in areas requiring deeper technical understanding.

The table further shows the skewness and kurtosis values for each question. Skewness ranged from 0.06 to 0.67, indicating that the data distribution for most questions was relatively symmetrical. However, further analysis of individual questions with significant skewness values might be warranted to explore potential biases in student responses. Figure 5 shows the mean scores of the nineteen questions measuring knowledge and skills of Palestinian students on precision agriculture.

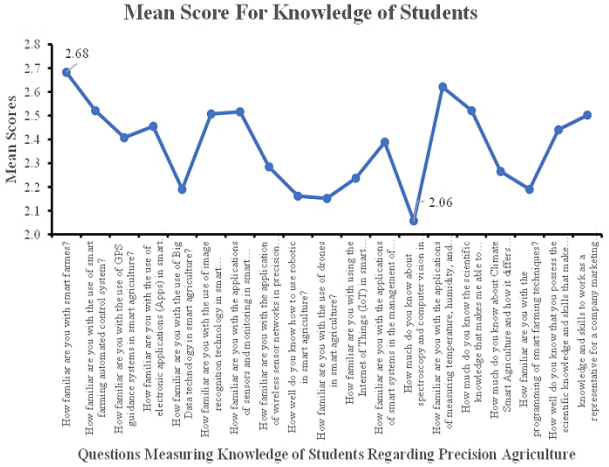

Fig 5. Line graph showing mean scores of the nineteen questions measuring knowledge and skills of Palestinian students on precision agriculture

Table 4 presents Cronbach's alpha coefficients for the two measurement scales used in the study. Cronbach's alpha is a measure of internal consistency, indicating the degree to which items within a scale assess the same underlying construct.

The "Knowledge and Skills" scale, comprised of nineteen items, demonstrated a satisfactory level of internal consistency with a Cronbach's alpha of .961. The "Perception" scale, initially containing ten items, underwent a modification. Question 7, worded as "I think that PA is far from being applied in my field of specialization," was removed due to its negative impact on the overall scale reliability. Following this removal, the revised "Perception" scale with nine items yielded a high Cronbach's alpha of .705, indicating a strong level of internal consistency.

Table 4. Cronbach's Alpha Reliability Coefficients for Knowledge and Skills and Perception Scales

Scale	No of Items	Alpha
Perception	9	0.705
Knowledge and Skills	19	0.961

An independent samples t-test was performed to evaluate gender differences in perception and knowledge and skills related to precision agriculture (PA) among Palestinian students (Table 5). In terms of perception, there was a statistically significant difference between females (M = 3.59, SD = 0.49) and males (M = 3.74, SD = 0.46); (t (209) = -2.26, p < .05), with a small effect size (Cohen's d = 0.31). This suggests that male students have a slightly higher perception of PA than female students.

Table 5. Gender Differences in Knowledge and Perception of Precision Agriculture

	Female		Male				
Scales	M	SD	M	SD	t (209)	p-value	Cohen's d
Perception	3.59	0.49	3.74	0.46	-2.26	<.05	0.31
Knowledge and Skills	2.17	0.56	2.61	0.75	-4.79	<.001	0.67

In terms of perception, there was a statistically significant difference between females (M = 3.59, SD = 0.49) and males (M = 3.74, SD = 0.46); (t (209) = -2.26, p < .05), with a small effect size (Cohen's d = 0.31). This suggests that male students have a slightly higher perception of PA than female students.

Regarding knowledge and skills, a significant difference was also found between females (M = 2.17, SD = 0.56) and males (M = 2.61, SD = 0.75); (t (209) = -4.79, p < .001), with a medium effect size (Cohen's d = 0.67). This indicates that male students reported higher levels of knowledge and skills in PA compared to their female counterparts.

These findings suggest that gender differences exist in both the perception of and the self-reported knowledge and skills in PA, with males scoring higher in both domains. The implications of these differences warrant further investigation to understand the underlying factors contributing to this disparity and to develop strategies to enhance PA education for all students. Therefore, hypothesis 1, which stated that there is a significant difference in the knowledge of precision agriculture between male and female Palestinian university students enrolled in agriculture programs, is supported. The Mean differences in students' perception and knowledge and skills on precision agriculture based on gender is shown in Figure 6.

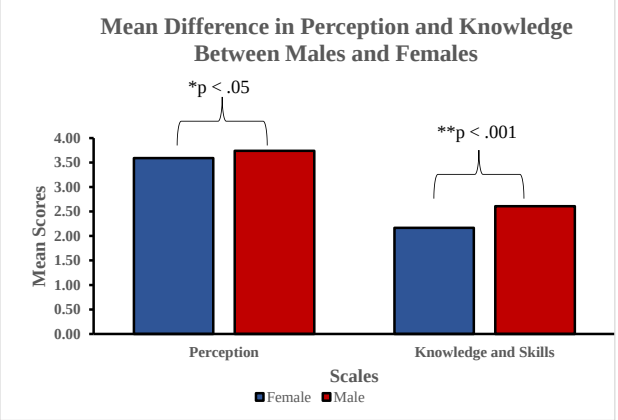

Fig 6. Mean differences in students' perception and knowledge and skills on precision agriculture based on gender.

Table 6. Gender Differences in Knowledge and Perception of Precision Agriculture

Scales	ANNU	PTUK	HU	AUG	QOU	F(4,206)	p-valu
Perception	3.50_a (.51)	3.72_b (.44)	3.55_c (.46)	3.78_a (.45)	3.80_e (.45)	3.745	<.0
Knowledge and Skills	2.16_a (.63)	2.24_b (.65)	2.27_c (.47)	$2.77_{a,b,c,e}$ (.73)	2.32_e (.75)	7.207	<.00

Note. Means Sharing common subscripts are significantly different from each other

A one-way ANOVA was performed to assess the differences in perception and knowledge and skills related to precision agriculture (PA) among students from various universities. For perception, the ANOVA results indicated a significant effect of university on student perceptions of PA, (F (4, 206) = 3.745, p < .01). A Tukey HSD post hoc test revealed that this difference was primarily between students from ANNU (M = 3.50, SD = 0.51) and AUG (M = 3.78, SD = 0.45), with AUG students showing a higher perception of PA.

In terms of knowledge and skills, the ANOVA was also significant, (F (4, 206) = 7.207, p < .001). The Tukey HSD post hoc test indicated that students from AUG (M = 2.77, SD = 0.73) had significantly higher knowledge and skills in PA compared to their counterparts from ANNU (M = 2.16, SD = 0.63), PTUK (M = 2.24, SD = 0.65), HU (M = 2.27, SD = 0.47), and QOU (M = 2.32, SD = 0.75).

These results suggest that there are significant differences in both perception and knowledge and skills in PA among students from different universities, with AUG students demonstrating higher levels in both domains. This may reflect the influence of university-specific curricula, resources, and emphasis on PA education. The findings highlight the importance of university education in shaping students' perceptions and knowledge of PA. Therefore, hypotheses 4 and 5 are supported. Graphical representation of the findings are shown in Figure 7 and 8.

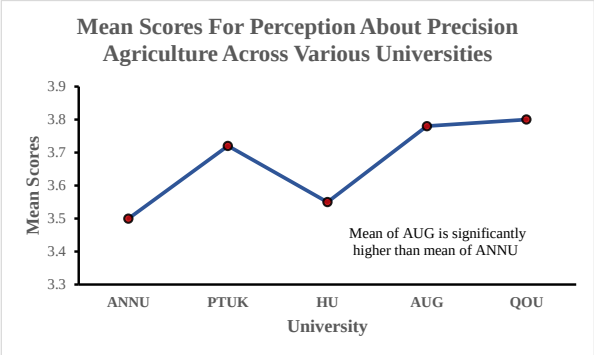

Fig 7. Line graph showing mean scores for perception of Palestinian students about precision agriculture based on various universities.

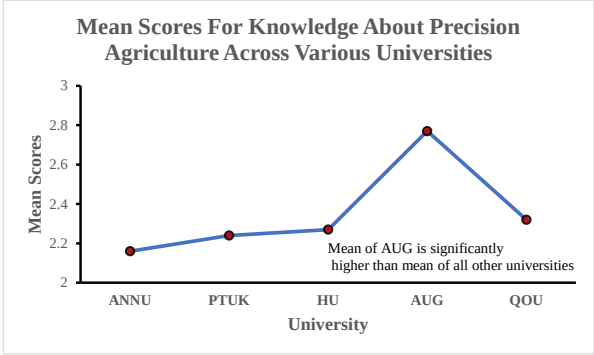

Fig 8. Line graph showing mean scores for knowledge of Palestinian students about precision agriculture based on various universities.

A one-way ANOVA was utilized to determine if there were significant differences in perception and knowledge and skills related to precision agriculture (PA) among Palestinian students at different academic levels. The analysis for perception indicated no significant differences across the academic levels, (F (2, 208) = 0.150, p = .861). Similarly, for knowledge and skills, the results were not statistically significant, (F (2, 208) = 1.706, p = .184). Therefore, hypotheses 2 and 3 are not supported.

These findings suggest that the academic level—whether third grade, fourth grade, or master's—does not significantly influence students' perception of or knowledge and skills in PA. This lack of significant difference implies that students across these academic levels have a relatively uniform perception and understanding of PA, which could be attributed to consistent exposure to PA concepts throughout their education. The results indicate that further educational interventions in PA should be designed with consideration for factors other than academic level. The graphical representation is shown in Figure 9 and 10.

Table 7. Results of One-Way ANOVA between Academic Levels and Perception and Knowledge and Skills Scales regarding Precision Agriculture among Palestinian University Students

Scales	Third Grade	Fourth Grade	Masters	F(2,208)	p-value
Perception	3.65 (.48)	3.65 (.49)	3.70 (.48)	0.150	0.861
Knowledge and Skills	2.37 (.77)	2.44 (.65)	2.18 (.59)	1.706	0.184

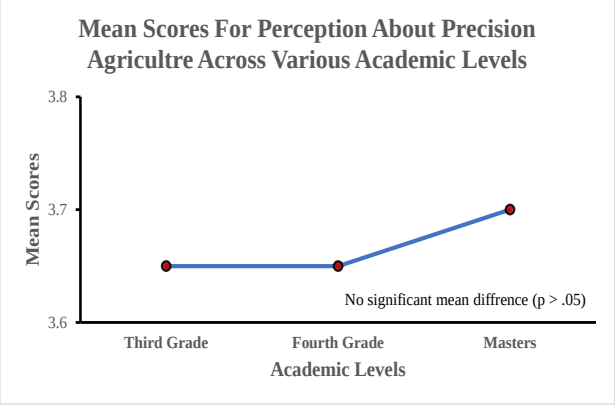

Fig 9. Line graph showing mean scores for perception of Palestinian students about precision agriculture based on various academic levels.

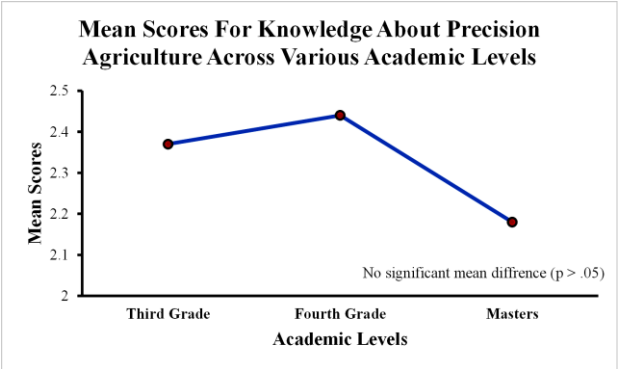

Fig 10. Line graph showing mean scores for knowledge and skills of Palestinian students about precision agriculture based on various academic levels.

Table 8. Frequency Distribution of Perception Scale Scores Among Palestinian Students

Mean scores	Frequency	Percent	Cumulative Percent
2.44	1	0.5	0.5
2.56	2	0.9	1.4
2.67	4	1.9	3.3
2.78	6	2.8	6.2
2.89	2	0.9	7.1
3.00	8	3.8	10.9
3.11	9	4.3	15.2
3.22	13	6.2	21.3
3.33	18	8.5	29.9
3.44	17	8.1	37.9
3.56	12	5.7	43.6
3.67	23	10.9	54.5
3.78	17	8.1	62.6
3.89	17	8.1	70.6
4.00	20	9.5	80.1
4.11	10	4.7	84.8
4.22	9	4.3	89.1
4.33	8	3.8	92.9
4.44	8	3.8	96.7
4.56	5	2.4	99.1
4.67	1	0.5	99.5
4.78	1	0.5	100.0

A frequency analysis was conducted on the perception scale to evaluate Palestinian students' attitudes towards precision agriculture (PA). The scale's mean scores ranged from 2.44 to 4.78, with the midpoint of the scale (3.00) indicating a neutral stance. The analysis indicated that a substantial proportion of students (89%; N = 188) scored above this neutral point, suggesting a generally positive perception of PA. However, it is important to note that 43.6% of the students had mean scores of 3.56 or below (N = 92), which does not support the assumption that 50% of Palestinian students have a 'good' perception of PA, as 'good' would be indicated by scores significantly higher than the midpoint. This finding suggests that while there is a tendency towards a positive perception of PA, there is still a considerable portion of the student

population that remains neutral or has reservations about PA. Figure 11 shows cumulative percentage of mean score for perception on precision agriculture for Palestinian students.

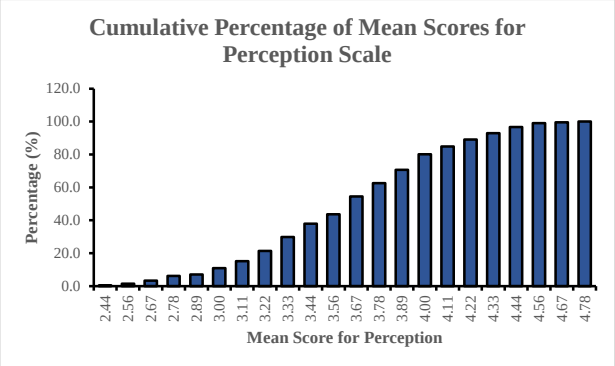

Fig 11. Bar graph showing cumulative percentage of mean score for perception on precision agriculture for Palestinian students.

Table 9. Frequency Distribution of Knowledge Scale Scores Among Palestinian Students

Mean Scores	Freq.	Percent	Cumulative Percent
1.00	9	4.3	4.3
1.05	4	1.9	6.2
1.16	2	0.9	7.1
1.21	1	0.5	7.6
1.26	2	0.9	8.5
1.32	2	0.9	9.5
1.37	2	0.9	10.4
1.42	2	0.9	11.4
1.47	2	0.9	12.3
1.53	2	0.9	13.3
1.58	1	0.5	13.7
1.63	1	0.5	14.2
1.74	4	1.9	16.1
1.84	3	1.4	17.5
1.89	2	0.9	18.5
1.95	3	1.4	19.9
2.00	15	7.1	27.0
2.05	11	5.2	32.2
2.11	13	6.2	38.4
2.16	8	3.8	42.2
2.21	4	1.9	44.1
2.26	10	4.7	48.8
2.32	3	1.4	50.2
2.37	7	3.3	53.6
2.42	5	2.4	55.9
2.47	7	3.3	59.2
2.53	8	3.8	63.0
2.58	7	3.3	66.4
2.63	5	2.4	68.7
2.74	5	2.4	71.1
2.79	7	3.3	74.4
2.84	3	1.4	75.8
2.89	6	2.8	78.7
2.95	2	0.9	79.6
3.00	11	5.2	84.8
3.11	3	1.4	86.3
3.16	3	1.4	87.7
3.21	3	1.4	89.1
3.32	2	0.9	90.0
3.37	4	1.9	91.9
3.42	4	1.9	93.8
3.47	2	0.9	94.8
3.53	1	0.5	95.3
3.58	2	0.9	96.2
3.63	1	0.5	96.7
3.68	1	0.5	97.2
3.84	1	0.5	97.6
3.89	1	0.5	98.1
3.95	1	0.5	98.6
4.00	2	0.9	99.5
4.16	1	0.5	100.0

The distribution of student responses on the knowledge scale was analyzed using frequency analysis. Scores on the five-point Likert scale, ranging from 1 ("Very Low") to 5 ("Very High"), revealed a wider spread compared to the perception scale. Over half of the students (N = 106, 50.2%) scored at or below 2.32. Furthermore, a substantial portion (N = 179, 84.8%) scored 3.00 or lower. A score of 3.00 represents the neutral point on the Likert scale. These findings suggest that a significant majority of students possess knowledge and skills related to precision agriculture that fall within the "Low" to "Somewhat Moderate" range.

This data contradicts the initial assumption that 50% of Palestinian students would demonstrate "good" knowledge of precision agriculture. The results indicate a need for improvement in students' foundational understanding of precision agriculture concepts. Figure 12 shows cumulative percentage of mean score for knowledge and skills on precision agriculture for Palestinian students.

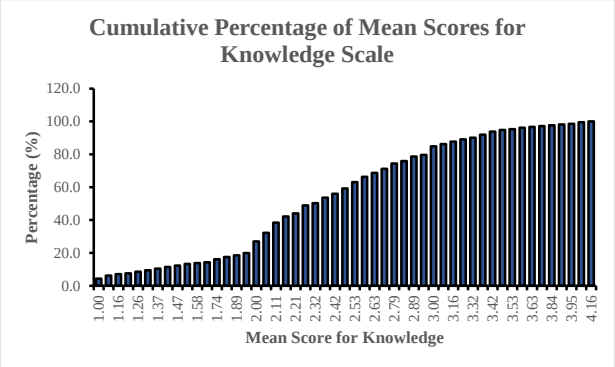

Fig 12. Bar graph showing cumulative percentage of mean score for knowledge and skills on precision agriculture for Palestinian students.

3 DISCUSSIONS OF THE RESULTS

This study investigated Palestinian university students' knowledge, skills, and perception regarding precision agriculture (PA). The findings provide valuable insights into the current state of PA awareness and preparedness among this student population.

Generally, the stand of students for PA is positive and there is a strong believe among them that universities have a significant contribution to introduce PA into Palestine. Students believe that the universities are the main sources to improve the knowledge about PA through practical and theoretical courses and are the best way to enhance their knowledge about PA. This is in agreement with the results reported by Bournaris et al (2022).

Knowledge and Skills

The analysis of the knowledge and skills scale revealed that, on average, students scored within the "Low" to "Average" range. Over half of the participants demonstrated knowledge and skills that fell below the neutral point on the Likert scale. These results suggest a need for significant improvement in students' foundational understanding of PA concepts. While some familiarity was evident with topics like "smart farms" and basic data collection methods, knowledge regarding more advanced technologies like spectroscopy and drone use was limited.

These findings align with previous studies highlighting the limited integration of PA into agricultural education programs in developing countries (Nguyen et al., 2023). The lack of exposure to PA principles and practices within the curriculum may contribute to the observed knowledge gap.

Perception

The perception scale results presented a more positive picture. While the initial assumption of 50% of students exhibiting "good" perception was not entirely supported, a clear trend of agreement with the importance of PA emerged. Nearly 90% of students scored above the neutral point, indicating a general recognition of the need for PA curriculum development and the potential benefits it offers. This positive perception suggests that students are receptive to incorporating PA into their agricultural education.

This is in agreement with the results reported by Reichardt et al. (2009) and Kountios et al (2018). Also Say et al (2018) reported that adoption rate of PA technologies is in an increasing trend in some developed and developing countries.

Interestingly, a significant difference in perception scores was found between universities. Students from ANNU reported a slightly lower perception compared to those from AUG. This might be due to existing initiatives or specific faculty expertise in PA at AUG, potentially leading to greater awareness among students. Further investigation into these university-level variations could be informative.

Gender Differences

A notable finding was the statistically significant difference in knowledge and skills scores between genders. Male students scored moderately higher than females, suggesting a potential gender gap in PA knowledge. Several factors, such as unequal access to educational resources or traditional gender roles within agriculture, could contribute to this disparity. Future research exploring the underlying reasons for this difference is warranted.

4 CONCLUDING REMARKS

The study highlighted the need for increased emphasis on PA education for Palestinian university students enrolled in agriculture programs. While students expressed a positive perception of PA, their knowledge and skills remain at a relatively low level. Curriculum development efforts that integrate PA concepts and provide opportunities for practical application are crucial. Addressing the identified gender gap and ensuring equitable access to PA education are also important considerations. By equipping future agricultural professionals with the necessary knowledge and skills in PA, increased efficiency, sustainability, and productivity can be achieved within the Palestinian agricultural sector.

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ERASMUS+ PROJECT 'BENEFIT' – BOOSTING INNOVATION IN DIGITAL FARMING

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Keywords

BENEFIT, Erasmus+, digital farming, precious agriculture, EU–Palestine cooperation, Agriculture 4.0, aquaponics farm

Abstract

The article presents the Erasmus+ project BENEFIT implemented from 2020 to 2023 as an example of cooperation between universities in the European Union and Palestine. The key objective of the project was to support digital farms and the application of smart technologies in precision agriculture. The project was primarily focused on the university sphere, so one of the main outputs was the preparation of study courses related to precision agriculture at Palestinian universities, where European partners oversaw evaluation to ensure the courses met modern education quality requirements. The project also included developing new technologies and transferring ideas and solutions to the commercial sphere. This paper is focused on the part of the project solved at VŠTE in České Budějovice. Among other things, VŠTE analysed successful digital farm solutions in the Czech Republic and supervised some of the prepared training courses. As part of the project solution, a scientific meeting was also held in Prague in September 2022, where the method of aquaponics fish farming combined with the cultivation of useful plants (Aquaponia Hostomice) was presented to the Palestinian participants.

1. Introduction

In 2020, the project BENEFIT (609544-EPP-1-2019-1-PS-EPPKA-CBHE-JP, http://benefit.edu.ps) was launched. The project was run under the Erasmus+ Capacity Building for Higher Education programme by a consortium of Higher Educational Institutions (HEIs) from European Union (EU) countries – Czechia (VŠTE in České Budějovice), Slovakia (Slovak University of Agriculture in Nitra), Greece (University of Patras) and Bulgaria (University of Ruse) connected with five universities in Palestine (Al-Quds Open University, An-Najah National University, University Hebron, Al-Istiqlal University, Palestine Technical University 'Khadoorie') to address the challenges faced by Palestine regarding applying information and communication technologies (ICT) and technological innovations in agriculture. Digital farming, also called precision agriculture (PA), is an innovative concept in the Middle East, especially in Palestine. Precision agriculture is a whole-farm management approach using innovative technologies such as ICT, global navigation satellite system (GNSS) positioning data, remote sensing and proximal data gathering. This is not specifically only about the technologies but about the overall concept putting an accent on understanding how the technologies can make farming more accurate and controlled (Palková et al., 2022). In 'National Agricultural Sector Strategy 2017-2022 – Resilience and Sustainable Development' (2016), several key factors were identified that negatively impacted the development of (sustainable) agriculture: a weak capacity to keep up with technological progress, low competitiveness of local products and abandoning production processes. Automated robotic systems can bring agriculture flexibility in farmer decision making to select the optimal technological arrangements during the field crop production process, which entails economic, environmental and social aspects.

The main goals of the BENEFIT project are:

- Involve Palestinian HEIs in the PA research movement in Europe.

- Encourage Palestinian researchers and academics to have an interest in topics related to the concept, domains, tools and digital technology of PA (e.g. a wide array of items such as GNSS guidance, control systems, sensors, robotics, drones, autonomous vehicles, variable-rate technology, GNSS-based soil sampling, automated hardware, telematics and software).
- Define a qualification profile and the PA curriculum and elaborate assessment standards.
- Involve Palestinian farmers in PA processes, enhancing them with critical-reflective and creative skills.

Parallel with the abovementioned activities, the installation process was realised for equipment related to digital farming laboratories, including equipment deployment and testing. Al-Quds Open University established an innovative management structure to ensure the successful implementation of all activities and the collaboration of all partners to achieve the intended results and impact.

2. Methodology

The project's innovative character serves to the capacity building of Palestinian HEIs and addresses the challenges EU countries face regarding ICT, technological developments and creating a global research framework that will promote innovation and integration of the newest digital technologies into agriculture and rural development. The following actions have been proposed as possible solutions to these problems:

- Work with the private sector to keep abreast of new technologies and encourage their entry into the local market.
- Continuously train human resources in the agricultural sector to keep current with technical agricultural progress.
- Establish a hub for digital agriculture (BENEFIT Incubator).
- Develop a PA e-Repository.
- Design, pilot and evaluate the initial courses focusing on PA.
- Create an international PA research network.

Palestinian university teachers and researchers represent BENEFIT's primary target group. The second (indirect) group includes students, school teachers, innovators, media-related education and business (i.e. chambers of commerce) and policymakers. These groups will create a dynamic shift to launch the concept of digital farming into different sectors, particularly the commercial sector and practical implementation.

Moreover, having partners from EU countries will help Palestinian HEIs develop their quality of services on many levels, including the capacity building of academic and technical staff, setting up the project to European benchmarking standards and allowing for transparency and efficient monitoring and follow-up. Furthermore, as the project involves a consortium of diverse actors with varied methodologies, knowledge and skills, it would be crucial to have EU partners conduct the change and avoid potential obstacles as they have relatively extensive related experience.

In addition, the EU partnership will ensure that the project will be durable through a dissemination strategy. The EU partners will share the project's outcomes and outputs and create/facilitate new networking possibilities with other EU partners.

3. Case studies of digital farming in Czechia

To involve Palestinian HEIs in the PA research movement in Europe, VŠTE analysed existing PA projects in the Czech Republic. In this chapter, several case studies of successful projects are presented. The ideas of these projects can be a source of best practices for universities that participated in the BENEFIT project.

3.1. CleverFarm

An example of a successful PA startup is the Czech company CleverFarm, founded in 2016 (https://www.cleverfarm.ag/). The company offers a whole range of products and services to Czech farmers, with the company's main product being 'smart maps' in the form of a software application (the basic version is free, but additional modules can be purchased). Data from available maps of agricultural land are linked with data from the cadastre, satellite images and meteorological data. The application then supplements this data with information on compliance with agricultural and ecological regulations (fertilisation records, nitrate directive monitoring, Land Parcel Identification System, etc.). Furthermore, the application provides a three-day weather forecast for the monitored location.

Paid add-on modules allow the application to be connected to smart machines (e.g. tractors communicating via ISOBUS ISO 11783 interface) and thus manage, for example, fertilisation. Another module works with online soil sensors and includes an Internet of Things (IoT) Salinity sensor (measures soil moisture, temperature and conductivity), an Absorb soil sensor (measures water potential in the soil) and a Volumetric sensor (measures the volume of water in the soil). Sensors can be connected using SigFox, LoRa, or NB-IoT networks. They offer protection with an IP68 rating and are powered by batteries that have a lifespan of 1.5 to 2 years. The application can also predict selected plant diseases based on measurements (damage caused by corn borers, septoria and phaeosphaeria wheat spots, fusarium head blight or potato gangrene).

Figure 1. Soil sensors from CleverFarm Source: (https://www.cleverfarm.ag/products/sensors/)

Another paid module of the application obtains current information from the cadastre (checking the validity of rental contracts, keeping an overview of paid rent, etc.) and creates documents for tax returns.

The CleverFarm system has been deployed in several agricultural enterprises and has references abroad. For example, it has been employed in Chile to cultivate sour cherries in water-scarce areas, where the optimisation of irrigation management has a significant impact on the economics of cultivation.

3.2. FishRAS

The FishRAS is a recirculation aquaculture system (RAS) project of students from the Czech University of Life Sciences, which consists of breeding fish in a system with a closed water cycle. The fish are kept in tanks with a filter system that cleans and oxygenates the water and returns it to the tanks. The main goal of this project is a significant reduction of water consumption, so this solution is especially attractive for countries facing limited water resources. Other advantages of RAS technologies are eliminating the threat of fish predators and preventing the spread of transmissible diseases.

Figure 2. FishRAS Source: (Ryby-Vlček Facebook, 07-Mar-2019)

3.3. Vertical hydroponics – Feel Greens

A commercial application of vertical hydroponics can be observed in Fosfa a.s.'s Feel Greens farm in Břeclav, South Moravia (https://web.fosfa.cz/en/products/feel-greens/). It took three years to develop this multi-floor farming solution, which is particularly suitable for areas lacking space, such as densely populated regions or urban agglomerations. Compared to classic cultivation, this system only uses a tenth of the water. Hydroponics enables selling plants with a root ball, significantly prolonging their freshness during transport. Due to the closed water circulation and air filtration, no pesticides are needed, and cultivation has no waste. The company has plans to expand production in the near future.

3.4. Varistar

Varistar (https://www.variabilni-aplikace.cz/en/our-services/varistar-portal) offers added value by not selling specific products but a comprehensive service emphasising long-term operation. The company offers an application that integrates data collection from various sources, such as PlanetScope satellite images, soil analysis maps and drainage line maps, which make it possible to create maps of revenue potential and production zones. The system further enhances data utility by enabling Smart Scouting analysis, which helps identify potentially risky areas or zones where plants may fail. Preparing documents for variable soil processing or maps for variable stock fertilisation is also possible. The Varistar system enables connection with spreaders, sprayers and sowing machines of most major manufacturers, including AMAZONE, Bogballe, Fieldstar, Horsch, Kuhn, Kverneland, RDS, Vicon, Väderstad and others. Furthermore, the system supports remote (online) and unattended uploading of created application maps to the terminal of the application device.

3.5. Aquaponics Farm Aquaponia

During the BENEFIT scientific workshop in Prague in September 2022, Palestinian participants visited the aquaponics farm, Aquaponia s.r.o, in Hostomice (near Beroun, 50 km from Prague). The farm focuses on the production of tilapia, trout, sturgeon and African catfish and cultivating herbs such as basil, chives, and baby lettuce. Fish produce natural waste that provides essential nutrients plants require to develop. While the plants absorb nutrients and purify the water, the clean, oxygen-rich water is reintroduced to the fish ponds, reducing water consumption by about 90%. Both the fish and plant production are completely ecological, without any chemical additives. This model could be transferred to Palestine due to considerable water savings and the popularity of tilapia fish in the Jordan Valley.

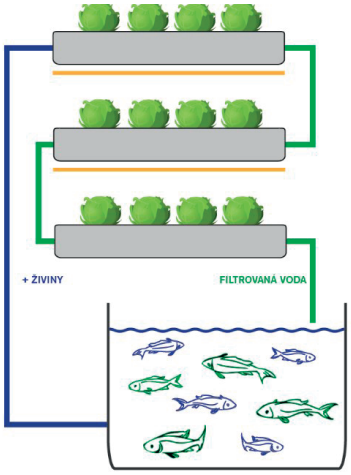

Figure 3. Scheme of aquaponics production Source: (https://aquaponia.cz/jak-to-delame/)

Figure 4. Aquaponics production – fish and plants. Aquaponia Hostomice Source: own

Although the conditions for agriculture in Palestine are different from the Czech Republic (different climate, legislation, etc.), the mentioned case studies of digital farming are focused on transferable technological aspects.

4. New digital farming courses and technologies developed at Palestinian HEIs within the BENEFIT project

Under the supervision of EU project partners, Palestinian universities prepared new courses focused on PA, bought new equipment for PA laboratories and developed new technologies. Some examples of the project BENEFIT outputs are described below.

4.1. AgriLive Monitoring System

A real-time monitoring system based on IoT technology, AgriLive, was developed at Al-Istiqlal University in Jericho to collect data and transmit it to cloud servers.

Figure 5. AgriLive sensor Source: (Al-Istiqlal University, Dr Walid Khalilia)

AgriLive allows multiuser authentication and wireless connection. It is powered by either solar energy or battery and provides a wide range of hydrological sensors, including temperature, pressure, soil moisture, electrical conductivity (salinity), pH and flow meter, with the ability to control actuators like valves or pumps. Current data is presented as a real-time dashboard, while historical data is in the form of graph reports. This data can be exported to Mircosoft Excel for further processing. The system is currently utilised at student-managed date palm and banana farms.

4.2. Precision Agriculture Course at Palestinian Technical University Kadoorie

The course consists of six modules:

- Measuring Soil Moisture and Temperature in Precision Farming
- Precision Technology in Irrigation Scheduling – water flow in pipelines and open channels, programming and management of irrigation water and irrigation scheduling
- Precision Technology in Fertilizers Management – soil nutrients reaction and transformation, soil nutrients evaluation, methods of fertilisers application and fertiliser programming,
- Big Data Management
- Control of Smart Greenhouses – based on analyses by Gaikwad et al. (2016) and Dwinugroho (2021)

- Precision Technology in Poultry Farms and Hydroponic Units – principles of PA in crop and livestock production, data acquisition and management, the application of the sensor in poultry farms and in the cultivation of hydroponic barley
- Precision Technology in Plant Physiology

4.3. Digital Farming and Environmental Safety Course

This course, prepared by Al-Istiqlal University, reviews the principles of photogrammetry and remote sensing related to agriculture, land surveying, geographic information systems and environmental safety. It includes understanding the necessary mathematics and information technology concepts required for image processing and analysis. Photography and digital photography are covered, emphasising designing and creating the data required to obtain survey information following established standards. In May 2022, a BENEFIT project meeting at SZU Nitra (Slovakia) discussed the usage of unmanned aerial vehicles (UAVs) for detecting plant diseases. Čermáková and Danel (2022) published a detailed analysis of UAVs in PA, and project INVARO, which focuses on detecting invasive plants by UAV, was referenced. These findings can also be applied to the teaching of 'digital farming' courses prepared during the BENEFIT project.

5. Conclusion

Digital farming still represents a new field of science. Even if there are five agricultural faculties in Palestine, there are no specialists at the national level. Therefore, providing researchers at national universities with new experience and knowledge in PA is a national priority for Palestine. To accelerate the adoption of digital farming, researchers and technicians must intensively participate in scientific visits, workshops and training courses. The BENEFIT project and its activities can significantly improve the implementation of innovative technologies in agriculture in Palestine and increase the cooperation between the EU and Palestine.

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Boosting Innovation in Education and Research of Precision Agriculture in Palestine

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"Precision agriculture", also called "digital farming", is an innovative concept in the countries of Middle East and especially in Palestine. This is not specifically about the technologies, but about the overall concept putting accent on understanding how the technologies can make the farming more accurate and controlled. In the document "National Agricultural Sector Strategy (2017-2022) "Resilience and Sustainable Development" as one of the main factors that had negative impact on (sustainable) agriculture development weak capacity to keep up with technological progress, low competitiveness of local products and abandoning production processes have been identified. As a possible solution of this problems the following two actions have been proposed:

1. Working with the private sector to keep abreast of new technologies and encouraging their entry into the local market and
2. Continuous training of human resources in the agricultural sector to keep abreast of technical agricultural progress.

The BENEFIT project (609544-EPP-1-2019-1-PS-EPPKA-CBHE-JP) which runs under the Erasmus+ Capacity Building for Higher Education programme tries to address the challenges faced by the Palestine regarding ICT, technological developments, and creating a global education and research framework for innovation and development regarding the integration of newest (digital) technologies into agriculture and rural development.

The article presents the main activities of the BENEFIT project that aim to:

1. Involve Palestinian HEI's in Research Movement related to Precision Agriculture in Europe.
2. Encourage Palestinian researchers and academics to have an interest to topics related to the concept, domains, tools and digital technology of the Precision Agriculture (e.g. a wide array of items such as GPS guidance, control systems, sensors, robotics, drones, autonomous vehicles, variable rate technology, GPS-based soil sampling, automated hardware, telematics, and software).
3. Define of a qualification profile and the curriculum in precision agriculture and the elaboration of assessment standards.
4. Involve Palestinian farmers into the precision agriculture processes, enhancing them with critical-reflective and creative skills.

Keywords: Erasmus+, precision agriculture, innovative syllabus, innovative technologies, capacity building, bologna process

1. INTRODUCTION

The agriculture sector in Palestine carries both economic and political importance. According to the ((Palestinian Central Bureau of Statistics, 2013)), this sector is employed about 11,5% of the labour force. Further, the agriculture income represents 5,6% of the gross domestic product (GDP) and accounts for 21% of the total exports. More notably, the agriculture in Palestine plays a central role in land protection from Israeli confiscation and settlements. Thus, the vision of the agriculture strategy "resilience and development" announced by ministry of agriculture (2017-2022), to be achieved during the coming years: to have a sustainable and feasible agriculture sector that can compete domestically and externally; and can effectively contribute to enhancing food security and the connection between the Palestinian people and their land, while also enhancing Palestinian state-building efforts through resource sovereignty. The environmental and political challenges are the main factors threaten the agriculture sector in Palestine. However, the effects of these issues are more intensified when

considered in the frame of Climate Change. In this perspective, water quantity and quality have been continuously declining during the last years. Further, the scarcity of land resources, rapid population growth, pollution of the aquifers and marine environment, desertification and land degradation are challenging. Under the regional climate changes such as changes in precipitation quantity, rain distribution, and the increases in seasonal temperature variability the environmental problems more intensified. Consequently, negative impact on agriculture sector my realized attributed to damage crops, decrease water availability, loss of biodiversity. Thus, can negatively affect the natural control of agricultural pests, and delay the growing seasons.

Generally, the industrial and/or digital technologies are expanding in global phenomenon with an emphasis on digitalisation, automation, control and robotics in various operations, related to environmental protection, soil cultivation management, optimization of crops nutrition, crop tending etc. The added value of automated robotic systems to agriculture is the enhancement of their flexibility, concerning farmer decision making to select the optimal technological arrangements during the production process of the field crops, which entails not only economic but also environmental and social aspects (Cviklovic & et al., 2016), (Toth & et al., 2016). As a result, the use of (digital) technologies could allow the agricultural sector to achieve big leaps in Palestine, especially in improving environmental protection, increasing productivity and introducing the cultivation of new strategic classes of crops. The knowledge about advanced agricultural technologies have therefore become key for the farmers in these regions, throughout the process of cultivation and harvest.

“Precision agriculture”, also called “digital farming”, is an innovative concept in the countries of Middle East and especially in Palestine. This is not specifically about the technologies, but about the overall concept putting accent on understanding how the technologies can make the farming more accurate and controlled.

In the document “National Agricultural Sector Strategy (2017-2022) “Resilience and Sustainable Development” (FAO, 2016) as one of the main factors that had negative impact on (sustainable) agriculture development weak capacity to keep up with technological progress, low competitiveness of local products and abandoning production processes have been identified. As a possible solution of this problems the following two actions have been proposed:

1. Working with the private sector to keep abreast of new technologies and encouraging their entry into the local market and
2. Continuous training of human resources in the agricultural sector to keep abreast of technical agricultural progress.

From these points of view, the innovative character of the BENEFIT project serves not only the capacity-building aspect for Palestinian HEIs, but also addresses the challenges faced by the Palestine regarding ICT, technological developments, and creating a global education and research framework for innovation and development regarding the integration of newest (digital) technologies into agriculture and rural development.

2. BENEFIT AIMS, OBJECTIVES AND TARGET GROUPS

Even if there are five agricultural faculties in Palestine, precision (SMART, digital) agriculture represents still new field of science in the country and there are no specialists at the national level. Therefore, providing researchers at the national universities with new experience and knowledge in precision agriculture becomes national priority. Especially, the palm sector, which is a promising and growing sector in Palestine, needs support and development. It should be taken consideration that its products are globally competitive and highly feasible economically due to its high quality and natural features of the region of the Jericho and Jordan valley.

In order to scale up the experience in precision agriculture, researchers and technicians must participate intensively in scientific visits, workshops and training courses. Establishing regional and/or international network for precise agriculture is a priority for research as well.

Bearing in mind that both the process of updated curricula and the introduction of new topics is slow because of limited funding, absence of well-qualified staffs’ appointment, and lack of close and regular contact with international specialists.

From this point of view, and considering the above-mentioned needs, the above-mentioned target groups in Palestine have been identified. :(i) academic staff, (ii) students and (iii) farmers. In more details, the target groups are:

- **Academic staff and researchers in the university**: this group requires advance capacity building improve their capacity about the adaption of new technological advancements, smart irrigation, and application prediction models in irrigation to conserve water, soil and plant as well as environmental protection; digital technological developments to provide, manage, and utilize the vast quantities of data required to understand spatial variations in crop yields and in the factors that affect yields. Advanced capacity building in yield mapping system it is also a crucial factor that needs improvement, etc.
- **Agronomists and extension agents**: this group not only in the public sector but also in the developing countries, is missing a continuous updated professional development continuous process for gaining both experience and knowledge. It is obvious that most of the agronomists acquired inadequate field's experience during practical courses in the university (in-service training). Various BENEFIT project activities such as workshops and Incubator's development at the QOU agricultural research centre will provide them with hands on experience and techniques in precision agriculture.
- **Students and trainees**: This group can be any individual which is shows strong interest in precision agriculture and special emphasis will be focused on women and isolated individuals, as people with special needs. In all Agriculture faculties students still missing the knowledge about precision agriculture and practical courses on this subject domain are not provided from Palestinian HEIs. BENEFIT project will add value on this area, providing them with new precision agriculture curricula and practical courses in the Incubator for precision agriculture that has been established at QOU's Agricultural Research Centre. This group needs capacity building on the design of irrigation systems, environment friendly fertilization, new technologies of water harvesting techniques and smart irrigation.
- **Farmers and agribusiness sector**: looking for new techniques in order to increase profitability, precision agriculture techniques will be provided to farmers and flexible tools that will increase the production and reduce any costs (e.g. the amount of water and fertilizers application) aligned these with less effort and time in the field service. The establishment of the Incubator at Al-Quds Open University Agricultural Research Centre will serve not only as a good platform to demonstrate the benefits of precise agriculture techniques but also for the flourishing of business start-up activities. Moreover, this target group will use the project results in the process of continual and/or informal training offered especially by the BENEFIT Incubator. The requested knowledge and skills should focus especially in the field of soil fertility, environmentally friendly fertilisation, fertilization management, using soil test information for fertilization process, effective water management, artificial irrigation controlled by ICT, and ways of selecting the most marketable crops for the region.
- **Policy makers**: precision agriculture applications, uses and benefits still remain ambitious for this group. Workshops and demonstration of a plethora of innovative farming activities will shed the light on the important of precision agriculture technology and encourage policy makers to consider this area as priority in the National Agricultural Strategic Plan

General objectives of the project are defined as follows:

- To involve Palestinian HEI's in Research Movement related to Precision Agriculture in Europe;
- To encourage both Palestinian researchers and academics to interests related to the concept, domains, tools and digital technology of the Precision Agriculture (e.g. a wide array of items such as GPS guidance, control systems, sensors, robotics, drones, autonomous vehicles, variable rate technology, GPS-based soil sampling, automated hardware, telematics, and software).
- To define a qualitative profile and a state-of-the-art curriculum in Precision Agriculture and elaborating reliable and valid assessment standards.
- To involve Palestinian farmers into the precision agriculture processes, enriching them not only with critical-reflective but also with creative skills.

Specific objectives of the project:

- Training Palestinian academic staff and researchers in "precision agriculture" through an in-service process, providing them with the knowledge to use and re-use useful Open Educational Resources (OER) and enhancing their professional development both for their self-esteem and to meet market's needs: "Expert in precision agriculture". The profile will be aligned with the specific socio-political conditions and educational systems in Palestine. (BENEFIT Training)
- Developing a joint, contemporary, open and flexible curriculum in precision agriculture will entail the need to focus not only on competences related to technology/digital innovation in the

agricultural sector, but, at the same time, to develop the capability of looking at the future, within a sustainable and optimistic view, to embracing new opportunities arising in the labour market. This will lead to the integration of a strong entrepreneurial dimension in the curriculum. (BENEFIT Curriculum)

- Developing a e-Repository with precision agriculture OER (BENEFIT Repository)
- Designing, piloting, and evaluating pilot and initial courses, focusing on the precision agriculture. These activities will be realized on the new or updated centres at the Palestinians' universities, e.g. Al-Istiqlal Dates Palm Research Center (BENEFIT Research Centers).
- Establishing a hub for digital agriculture (BENEFIT Incubator). This hub will be located at the Al-Quds Open University and will provide the essential equipment and instruments needed for digital agriculture application. Specifically, the advantages of such site are:
    - A platform for practical courses both for students and staff in the national universities, and
    - A good beginning as demonstration site for business start-up in Palestine, especially for Date palm growers. (link outputs of teaching and research with market needs).
- Creating an international research network about precision agriculture. (BENEFIT Community of Practice)
- Develop an e-precision agriculture space, that will provide the BENEFIT stakeholders- and not only- with a multidimensional space (e.g. OER PA Repository, Communities of Practices, Research Initiatives, etc.) (BENEFIT e-SPACE)
- In more details, these specific objectives will consist from:
    - BENEFIT in-service Training:
        - ToT (Training of the Trainers),
        - ToR (Term of References).
    - BENEFIT Implementation:
        - Curriculum (Concepts, Values, Methodologies),
        - Open Education Resources (Glossary, Theories, Tools, Technologies),
    - BENEFIT Incubator and research centres/laboratories.
    - BENEFIT Community of Practice:
        - Online Research Collaborative environment,
        - Relative Institutions (ARABIC and EU)
        - BENEFIT e-SPACE - Will include everything mentioned and will be integrated to Universities Central Page.

We expect that above-mentioned specific objectives will increase and scale up the experience and competent of researchers, teachers, students, agronomists, and extension agents in the universities, field, and markets in Palestine. As well, open the door to all stockholders in a national agriculture in Palestine and even the donors about the important of adopting precision agriculture technique as a good tool for:

- increasing the profitability of national agriculture sector;
- sustainable use and management of available resources (water and soil).

BENEFIT project with its incubator could leads eventually to start up commercial activities through encouraging national suppliers to import equipment for precision agriculture application in Palestine.

3. USED METHODOLOGY AND FIRST PROJECT ACTIVITIES

The BENEFIT project activities are based on the following main steps of the methodology:

- capacity-building of the team;
- the development and implementation process;
- the establishment of a platform for digital agriculture and piloting and
- conducting initially a short-term change inside the Palestinian HEIs and follow up with a long-term and a sustainable change.

Horizontal activities incorporate quality assurance, dissemination, and efficient management throughout the implementation of a Term of Reference at the end of each sub-phase inside the development process.

3.1. CAPACITY BUILDING & TRAINING

First activities of the BENEFIT project relates to the capacity building and training workshosps. First, of the planned three workshops, was launched in November, 2020. The aim of this workshop focus on the preparation of the theoretical background of Palestinian partners to start the practical work on designing the Precision Agriculture Curricula. The training topics that 1st workshop covered are following:

- Diagnostic Assessment Results,
- Synchronous E-learning Design,
- BENEFIT Instructional Design Framework,
- The case study of the EU universities on Bologna principles,
- Procedure of Educational Audit, Accreditation standards,
- Online Course's design through LMS platform,
- E-learning authoring tools for BENEFIT OER.

This starts on the pre-produced curricula and syllabus for each Palestinian University. This stage aims to define all the educational aspects of the new courses like core aim, main targets, learning objectives and outcomes. Activities related to this phase are the following:

- identification of the issues/problems/needs,
- characteristics, needs and desires of learners,
- identification of the theories and methods to accomplish intended outcomes,
- definition of short-term and long-term changes intended for learners,
- identification of the evaluation strategies for used methodology, developed content, and intended outcomes.

The output of this first phase will be the redaction of Terms of Reference that will have to be produced. It will serve as training blueprint to develop or enhance course or study program and enrich the learning, research and teaching process inside Palestinian Universities, focusing on precision agriculture in local communities. The main target is the better consideration of local, regional and national authorities and the potential implementation of concreate modern and open technologies and resources in agriculture as a stimulus at development of Palestinian economy and improving job creation.

4. CONCLUSIONS AND FUTURE WORK

Even if there are five agricultural faculties in Palestine, precision (SMART, digital) agriculture represents still new field of science in the country and there are no specialists at the national level. Therefore, providing researchers at the national universities with new experience and knowledge in precision agriculture becomes national priority. Especially, the palm sector, which is a promising and growing sector in Palestine, needs support and development. It should be taken consideration that its products are globally competitive and highly feasible economically due to its high quality and natural features of the region of the Jericho and Jordan valley.

In order to scale up the experience in precision agriculture, researchers and technicians must participate intensively in scientific visits, workshops and training courses. Establishing regional and/or international network for precise agriculture is a priority for researches as well.

Bearing in mind that both the process of updated curricula and the introduction of new topics is slow because of limited funding, absence of well-qualified staffs' appointment, and lack of close and regular contact with international specialists.

From this point of view, the project BENEFIT and its activities can bring significant improvement of the implementation of the innovative technologies in the agro sector in Palestine.

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ERASMUS+ PROJECTS' RESILIENCE DURING COVID-19 PANDEMIC: THE CASE OF BENEFIT PROJECT "BOOSTING INNOVATION IN EDUCATION AND RESEARCH OF PRECISION AGRICULTURE IN PALESTINE"

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Abstract

During the global COVID-19 pandemic, project implementation plans have become excessively difficult to execute as initially planned. The workload, giving the impossibility of meeting other team members, has been postponed and outcomes have become difficult to achieve within the specified time-frame. Project managers' endeavors to possess better performance are under increasing scrutiny during global disruptive events. Therefore, several contingency measures should be taken into account in order to tackle and mitigate the effects caused by the COVID-19 pandemic. This research seeks to fill this void. In particular, by taking the BENEFIT "Boosting Innovation in Education and Research of Precision Agriculture in Palestine" project as a case study, this research potentially attempts to explore how to manage project resilience during uncertain events, as well as identifying the different mechanisms to ensure project success.

BENEFIT is an international cooperation project funded by the Erasmus Plus of the European Union (Project #: 609544-EPP-1-2019-1-PS-EPPKA-CBHE-J). It seeks to facilitate knowledge transfer between European (Slovakia, Greece, Bulgaria and Czech Republic) and Palestinian Higher Education Institutions in the field of "agriculture".

The research provides a practical understanding of how to manage international cooperation projects during uncertain times, and a guide for further similar actions. It is concluded that the project consortium engaged in a number of practices in order to keep the project on track during uncertain situations, those are: revision and approval, adaptation, and goal-oriented monitoring. The findings also suggest that international cooperation projects can sustain resilience through maintaining efficient communication, information exchange, and flexibility across the project consortium. These mechanisms allow project partners to find constructive ways and context-specific approaches to carry out project activities, alleviate any raised problems, while addressing the negative implications caused by global issues such as COIVD-19 pandemic. The results of this case can be considered a modest step toward a more efficient and resilient project management of international cooperation projects during uncertain times.

Keywords: Project resilience, COVID-19, Project management, Erasmus+, Agriculture.

1 INTRODUCTION

In recent years, project management has been regarded as an important development tool in many Higher Education Institutions. A systematic methodology is still dominant today in most Higher Education Institutions to manage project, which emphasizes planning, communication, and control as important tools to achieve the desired outcomes. Planning contains detailed actions which should be followed in order to achieve the project objectives, within specific time frame, budget, and quality. Although action plans and their related activities are necessary, it is indeed not sufficient for project success [1]. Unexpected events and environmental turbulences are common during project lifecycle which might impact the implementation process [2].

In the context of project management, plans should be executed as effective and efficient as possible. Rigorous and detailed plans are developed and compliance to these plans is monitored on regular bases [3] in order to identify and avoid potential risks that may affect the project from achieving its intended outcomes [4]. However, it is almost an impossible endeavours to predict and realize all combinations of risks that may happen during the life cycle of the project [2], [3].

Risk management is a core knowledge areas in project management [5]. It consists of different mechanisms that reduce the probability of occurrence of an event or its impact on the project

outcomes [4]. Foreseen or known risks are identified early in the project planning phase and are included as a main component in the project plan. These known risks can be handled through excessive planning and control practices. However, project managers should be careful of excessive process control and enforcement policies since they might have adverse effect on productivity [6]. Therefore, target controls might be utilized in which the project manager monitors the achievement of outputs/outcomes instead of the actual work done by individual team members [3].

It appears that project management tools are suitable for projects with clear objectives and risks [3]–[5]. However, projects are unique and complex undertakings with unexpected events that may emerge over the lifecycle of the project. When risks are unavoidable and unforeseen, managers should go beyond traditional approaches to risk management by giving less attention to mechanisms that focus toward planning/controlling and more attention toward mechanisms that promote flexibility and learning [4], [7].

Unknown risks and events are more difficult to handle due to their unforeseen consequences [3], [7]. They might need learning strategy which might involve more problem solving skills, collaboration, and flexibility [3], [7], [8]. Although many research reviews have been established to explore known risks and their mitigation strategies, unknown occurrences and their impact on project resilience have received limited attention [4] [7]. Resilience can be described as the ability of a project to perform under disruptions and its capability to return to a stable state [9], [10]. In recent years, resilience has become an important concept that complement risk and uncertainty management [10].

Soderhom [2] suggested four different approaches to deal with unforeseen risks: innovative action, applying detachment strategies, setting up intensive meeting schedules and negotiating project conditions. In addition, the existing literature has advocated collaboration as an effective approach to respond to uncertainty, while ensuring project resilience [7], [10]–[13]. Furthermore, besides constant revision of the action plan, Soderholm [2] emphasized the importance of fine tuning, which is “a constant flow of information, experience, and people in to and out from the project” in order to meet environmental unexpected turbulences.

Moreover, Stock stated that “a greater extent of knowledge sharing secures success in the face of uncertainty because it facilitates a shared interpretation of unexpected alterations, emerging problems, and potential solutions… the level of project uncertainty reduces by acquiring essential, expert knowledge” [11, p. 2]. However, the efforts to resolve unknown risks and uncertainties might stagnate due to the introduction of new risks and challenges along the project implementation bath, and what is learned might become obsolete in a short period [3].

International cooperation projects are complex and many are executed under different cultural norms and regulations. Furthermore, some events in the external environment are difficult to recognize early during the project planning stage. Uncertainty may arise due to volatile market structures, changing stakeholders’ requirements, technological advancements, and environment turbulences [11], [14]–[17].The implications of uncertainty on project resilience and performance can be disastrous, such as delays, misunderstanding among project partners, opportunistic behaviour, over budgeting, and wasted knowledge [1], [2], [11], [12], [18]–[20].

The management of international cooperation projects involves a number of decision bodies and rules that are normally defined in the management manual of the project (a document established early in the project to define decision bodies, rules, and general policies). The primary focus in these projects is how to identify known risks and design proper responses. In the face of a changing environments, the project consortium might have to reconfigure existing internal capacities and potentially develop new capabilities in order to meet these risks [5]. There might be a need to adapt new resources and exploit specific competencies in order to address the unexpected situations and to ensure project resilience [21].

In summary, project resilience depends on how well the project is able to deal with uncertainties in the turbulent external environment [22]. Traditional approach to project management leads to the fact that projects are becoming less flexible to cope with uncertainty. Stock et al. [11] emphasized the importance of promoting adequate knowledge exchange and appropriate communication structures to reduce the impact of unforeseen uncertainties and risks. In addition, for projects in highly uncertain environment, promoting effective communication and coordination between the involved parties, e.g. through formal or informal coordination mechanisms, is important to ensure project resilience [22].

Although the literature related to the management of known risk is well established in the literature, there is a lack of literature related to project resilience under uncertain environment [7]. The question

of how Higher Education Institutions must act under high levels of uncertainty, such as COVID-19, to manage projects' resilience and achieve the desired outcomes is critical and should be addressed in forthcoming literature on project management. Exploring the relationship between project resilience and uncertainty/risk management in international cooperation projects is interesting for two reasons. Firstly, each project consists of a consortium with several partners. In addition, each partner in the project is subject to different internal policies and operates under different cultural environments. Therefore, different approaches might be utilized to ensure project resilience.

This research attempts to develop a framework that describes the process to mitigate risk and facilitate project resilience. It strives to explore the different mechanisms that reinforce project success during high uncertainty. The paper is expected to advance the international development projects management by providing Higher Education Institutions with a set of guidelines that may be helpful for effective uncertainty and risk management of educational, multi-cultural, international projects.

2 METHODOLOGY

The main aim of this research is to put forth a clear understanding of how to manage international cooperation projects under uncertain situations, such as COVID-19 pandemic. The research seeks to answer the following questions:

1 How to manage project resilience during unexpected events such as COVID-19 outbreak?

2 What are the different mechanisms that reinforce project resilience during high uncertainty?

To answer these questions, this research utilizes case study approach to investigate project resilience during uncertain times. It advocates in-depth analysis to explore the management approach of international cooperation project. It is based on an Erasmus Plus project entitled "Boosting Innovation in Education and Research of Precision Agriculture in Palestine - BENEFIT". This case project consists of ten sub-cases (10 partners), that have an ultimate aim to achieve the BENEFIT project objectives.

The case selection criteria were primarily based on the project type (international cooperation project) and the start date of the project. The BENEFIT project has started during the COVID-19 pandemic; this will facilitate the investigation of the issue in more details. Indeed, international cooperation projects have been under increasing pressure to mitigate and control risks caused by COVID-19 pandemic. They have advocated new mechanism to manage international relationships to reinforce project resilience and to ensure the achievement of project outcomes. Although all partners follow the same action plan and seek to achieve similar objectives, these partners have slightly different governance structures, operate under different cultural norms, and follow different policies. Therefore, each partner in the consortium can be considered a separate sub-case.

Data was collected based on semi-structured interviews, both face-to-face and via Zoom, with the project manager/coordinator in each consortium member. A total of ten interviews were performed, each interview lasted at one hour. Main topics discussed during interviews were project progress, the challenges faced by the project manager and actions taken at different points in time, and the process to manage change in projects during the pandemic. Data was then analysed and themes were established. The results were compared to existing literature and the contribution was highlighted.

3 RESULTS

The research is based on a case study of an international cooperation project, "BENEFIT". Data was collected and analysed to explore the different mechanism and the process adopted by participating Higher Education Institutions to manage international cooperation projects during COVID-19.

3.1 Description of the BENEFIT Project

BENEFIT is an international cooperation project funded by the Erasmus Plus of the European Union (Project #: 609544-EPP-1-2019-1-PS-EPPKA-CBHE-J). It seeks to facilitate knowledge transfer between European (Slovakia, Greece, Bulgaria and Czech Republic) and Palestinian Higher Education Institutions in the field of "agriculture". In particular, the project focuses on the integration of smart technologies in agriculture, while developing a joint, contemporary, and flexible curriculum in precision agriculture. Smart and precision agriculture have the potential of producing yields more efficiently and flexibly, while at the same time reducing the environmental impacts.

The project consists of five work packages. Each work package contains a systematic build-up of activities. The work packages are established based on a systematic review of institutions' needs in Palestine and an intensive consultation with partners from Europe. The work packages are:

- WP1: Capacity Building & Training.
- WP 2: Development, Implementation and Deployment.
- WP 3: Evaluation & Quality Assurance.
- WP 4: Dissemination and Piloting.
- WP 5: Project Management.

The project coordinator facilitates the coordination and communication process among partners. In addition, the coordinator is responsible for communication and reporting to the funding agency. The project has established an innovative management structure that will ensure successful implementation of all activities and effective collaboration of all partners to achieve the intended results and impact. The hierarchical structure of the project is shown in Figure 1. Furthermore, the management bodies and their role are listed below:

- The Project Coordinator: coordinate the communication process, while managing and following up on the work package leaders to ensure timely execution of activities.
- The Project Management Board (PMB): ensure smooth flow of project activities, ensure the achievement of outcomes, and also responsible for conflict resolution.
- Steering Committee: follow up the execution of the different work packages.
- Quality Assurance Committee (QA): responsible for the preparation of the quality management plan. It is also responsible for establishing clear procedures to measure the quality of the project and its outputs.

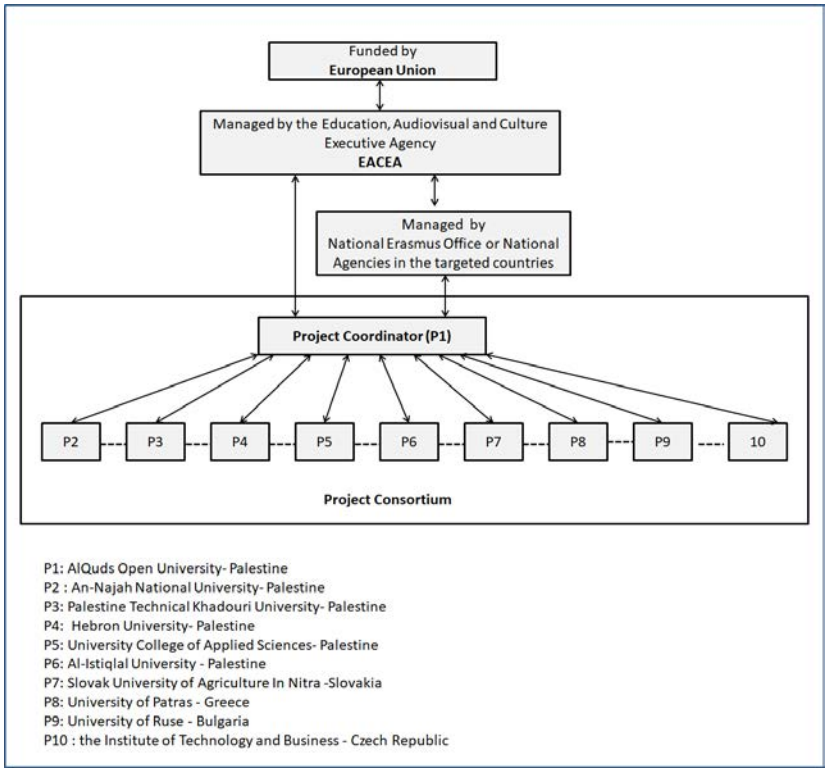

Figure 1: Project Management Structure.

3.2 Management for Resilience: The COVID-19 Uncertainty in BENEFIT Project

International cooperation projects run through different phases on their way to completion [2]. In the case of Erasmus Plus projects, these phases are: (a) Initiation, (b) Planning and proposal writing, (c)

Implementation/execution – if accepted for funding-, (d) Monitoring and evaluation, and (e) Project closure. These projects incorporate different expertise and skills over an extended period of time (up to three years). In addition, most projects have implementation teams in each institution. The team is assigned to the project and is led by a project manager responsible for the organization of activities, following up on team members, and gathering and validating project requirements. In this research we will focus only on the implementation/execution phase when the project progress is actually being achieved [2].

According to the analysis, uncertainties are divided into two major part, i.e. foreseen and unforeseen. Uncertainty had a direct negative impact on project performance [22]. The interviewees argued that foreseen uncertainties were detailed in the project plan and proposal, and the mitigation actions were well-established early during the planning and proposal writing phase. Plans were prepared as a mean to ensure the fulfilment of project objectives within a specific timeframe, quality, and cost limits [2]. In addition, the project manual was established early in the project lifecycle, and was shared with all partners. The manual states the different challenges and risks that might be faced during the project lifecycle. It proposes the procedures that should be followed if certain risks occur and mitigation plan to eliminate those risks. The Manual gives clear instruction to sustain continuity when known and foreseen risks occur. However, the interviewees believe that shifts and unforeseen risks in the external environment would impede the effective of planning and control approaches.

The project coordinator holds the responsibility to foresee potential issues and unexpected events, monitor the sources of uncertainty, and request change requirements if the issues become inevitable [2]. Indeed, departure from existing routines and established instructions will create anxiety among team members, which will impact project progress and productivity. In the case of COVID-19, contingent actions were established to address unforeseen uncertainty. These contingent actions resulted in changes in existing process and governance structure to ensure resilience and mitigate the impact of the COVID-19 pandemic on project progress and performance.

From the start of the COVID-19 pandemic, the EACEA has communicated clear instructions on how COVID-19 is affecting the different activities, what changes are taking place, and what help is available for project consortiums. The EACEA has adopted the progressive approach to manage the risk, which is focused on continuous adaptation to the unprecedented situation as it evolves. The agency has clarified and simplified the application of rules and procedures in collaboration with the National Erasmus Plus Office or the National agencies of the targeted countries. Indeed, flexibility measures have been taken by allowing replacement activities where the implementation of the project is impeded because of the coronavirus (for example, the unavailability of staff, inability to travel, impossibility of carrying activities due to the wide spread of COVID-19 in specific area).

The project coordinator has negotiated with partners how to deal the changes needed to mitigate the impact of the unexpected event. The consortium members, based on the instructions from the EACEA, have established a contingency plan. They have revised the existing plan and then proposed a new one with updated timeframe to execute the project activities. The revised plan was discussed with the Management Board as well as the quality assurance committee in order to approve the changes, e.g. changes in the timeframe, delays in activities, resource re-allocation. Detailed and extensive online meeting schedules have been established to closely monitor change and control project progress. These meetings stimulated information flow across the different implementation teams (exchange of experience), which is necessary to reduce the impact of uncertainty.

As a result, each institution has utilized its existing resources in a different way to keep the project on track. Changes to the initial plan are common during uncertain times, in particular for projects that extend over a period of time (three-year project in our case) [2]. The new plan was intuitive, i.e. depends on the past experience of the project managers, and goal-oriented. Goal-oriented approach is based on measuring productivity based on the achievement of outputs and outcomes instead of monitoring the actual work of team members. To ensure timely execution of project activities, the project consortium has developed an effective communication and coordination process to exchange practices and discuss project progress on regular basis. They utilized technological tools in order to discuss emergent issues and monitor the achievement of outputs.

The interviewees emphasized that risks during uncertain times should follow an adaptive approach, rather than following a strict risk management plan. This specifically true since COVID-19 outbreak was not only unforeseen, but also the impact on projects and when the pandemic will end is still unknown. Therefore, greater flexibility and adaptation should be encouraged and information sharing should be promoted in order to manage the situation and reduce its impact on the project progress.

However, the interviewees have emphasized that flexibility and adaptation require greater levels of empowerments and should be supported by web tool to enable project teams to communicate. The project coordinator has emphasized that the implementation team in each institution were empowered to make the necessary decisions to keep the project progress according to the defined schedule, at least as much as possible. Nevertheless, some of these decisions required re-shuffling of resources and activities [2], as well as the governance structure of the project at each institution. Changing the governance structure includes changes in decision bodies (involving staff with more technical knowledge), assigning new people to the implementation teams, and establishing new guidelines to control the project (e.g. movement to goal-oriented approach to follow up on team members).

According to the interviewees, effective communication and knowledge sharing among partners is vital to manage uncertain situations and allows rapid decision-making regarding the alternative actions in response to the emergent issues during execution [1]. In addition, knowledge and information sharing have helped in building team members' competencies and facilitated the integration of actions in overcoming unexpected situations [11]. Moreover, communication channels have facilitated the creation of a common frame of reference (a common understanding) among the different implementation teams.

The interviewees have highlighted that it is indeed difficult for the project coordinating team to develop formal plans and control mechanisms during uncertain events to monitor project progress. Implementation teams belong to different institutions and located in different countries, where face-to-face interactions are not allowed due to the pandemic. Therefore, the interviewees believe that promoting effective coordination and communication among the different teams, through formal or informal mechanisms, is more crucial during uncertain times [22]. Communication can promote different interpretation to deal with unexpected events, this is specifically crucial in international cooperation projects.

4 CONCLUSIONS

Based on a case study of an Erasmus Plus international cooperation project, this research strives to contribute to the stream of the literature exploring project resilience and risk management. It attempts to fill a gap in the literature by describing how project resilience can sustain and thrive during environmental variations [10]. The research brings a broader perspective to project resilience and offers an integrated framework for managing uncertain situation in international cooperation projects.

It is concluded that uncertain events negatively impact international cooperation project performance. However, the results show that projects that are subject to unexpected event should call for lower levels of formal planning and control and higher levels of flexibility, information sharing, interaction and collaboration. This appears to be consistent with the existing literature [11]–[13], [22]. It is concluded that the project consortium engaged in a number of practices in order to keep the project on track during uncertain situations, as depicted in Figure 2. The practices that have been observed are:

- Revision and Approval: the consortium have revised the existing plan and then proposed changes to cope with the uncertainty in the external environment. Approvals were taken internally (from the management board and quality assurance committees), and from the management/funding agency.
- Adaptation: since the end of pandemic and its consequences is still unknown, managers have continued to adapt to this unprecedented situation as it evolves. As a consequence, project activities have been rescheduled when possible, governance structure have been re-configured by involving new staff and applying new rules and procedures to follow up the progress of the project, and finally resources have been re-allocated across the different activities. Adaptation facilitates rapid decision-making regarding the alternative actions in response to the emergent issues.
- Goal-oriented monitoring: each project manager at each institution has followed a goal-oriented approach to monitor the progress of its implementation team. Goal-oriented approach focuses on the achievement of outputs/outcomes, rather than the actual work done by individuals, in order to ensure project resilience. Feedback loop have been established in order to adapt changes when needed.

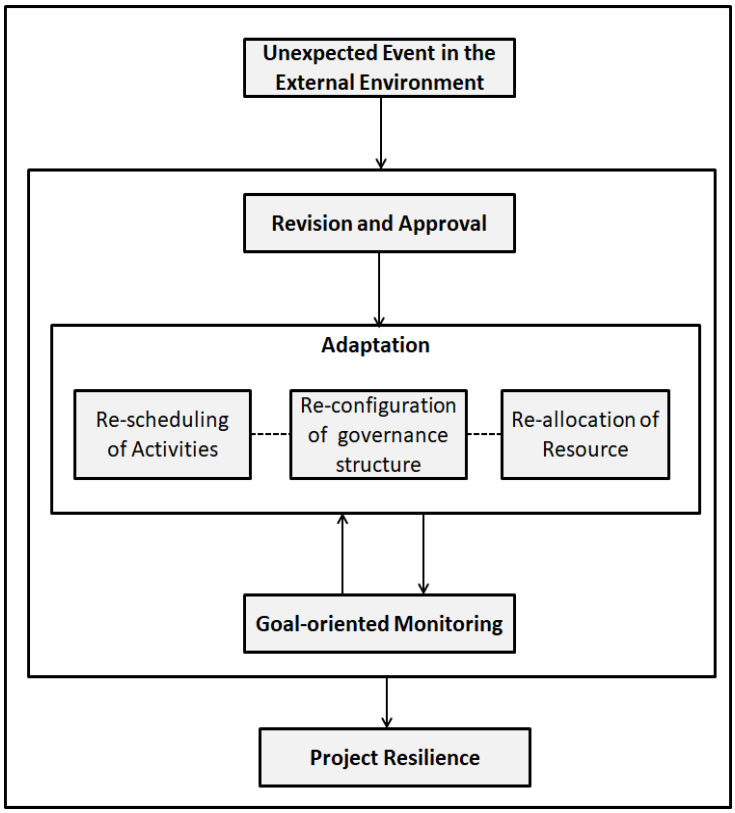

Figure 2: The Management Proces Followed by the Consurtium to Ensure Project Reslience During COVID-19 Outbreak.

All the practices above strive to mitigate risk and strengthen project resilience to be able to survive in the complex and uncertain environment. Greater flexibility, information sharing, and empowerment of implementation teams at each institution as well as effective communication are reported as being crucial during uncertainty. They facilitate rapid decision-making and alternative explanations to the unprecedented issues. These strategies allow the consortium members to think outside the established norms and procedures to execute the project and achieve high performance. Communication may include formal meeting schedule or informal approaches. It is important to gather more information and to include people with different knowledge to solve unexpected events. Frequent interactions between the project partners can facilitate knowledge transfer and promote a shared understanding of the issue.

Adaptation as part of the resilience strategy leads to constant state of readiness in order to quickly respond to dynamic changes in the external environment. These continuous adaptations will promote the project to return to the state of predictability. The utilization of an adaptive approach to project resilience allows the implementation teams to achieve the project objectives in more predictable manner as the uncertainty evolve overtime.

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