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# INFORMATION TECHNOLOGISTS' EXPLORATION AND EVALUATION ON TECHNICAL QUALITY OF DEVELOPED HYDROPONIC SYSTEM BASED ON ISO 25010 SOFTWARE

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**Abstract:** The IT experts' evaluation of the established Hydroponics System is critical; the study found that the overall mean rating of IT experts in terms of the full ISO 25010 quality criteria was outstanding. This indicates that IT specialists found at least two proofs of the quality's existence, with no errors or revisions in any of its attributes. Hardware and software that will be used in the creation of an Ebb and Flow Hydroponic System that is both automatic and maintenance-free. The review was conducted by a team of five IT specialists. Agricultural underpinnings would be extremely beneficial, given the productivity and discoveries achieved. Since the researcher only constructed a small size hydroponic system, it was also suggested that other researchers develop a system that can monitor acidity levels of pH solution, viscosity, oxygen, and other factors, as well as develop a larger scale system. It's also a good idea to improve security features because it aids in the process.

***Keyword****: IT experts, ISO 25010, Small scale hydroponic system*

## I. INTRODUCTION

Growing plants has traditionally been done with soil as the growing medium. An alternative medium is using a nutrient solution mainly composed of water, with minerals diluted in the water. The roots of the plants pick up nutrients from the solution to grow and develop. This kind of system is called hydroponic system. There are several different basic types of hydroponic systems which all share the same basic principle such as: Flood and Drain system, Drip System, Nutrient Film Technique (NFT) System and Aeroponic System. The systems can differ in some aspects such as some use either moving parts or no moving parts, recovery or non-recovery, but overall, the ingoing components are the same: a reservoir containing nutrient solution which is either pumped with water pump to the roots or with the roots submerged in the reservoir. The excess water from the moving system can either be recollected in the reservoir or not. Apart from nutrients, the plant requires light and air for the photosynthesis.

The hydroponic system which was utilized in this study is the Ebb and Flow also known as Flood and Drain System.

The figure shows the conceptual paradigm used for the development of the hydroponic system. For the input phase, the researcher conducted a series of interviews regarding the methods, process and flow of the development of Hydroponics system. Features and functionalities of the proposed system was also based on ISO/IEC 9126 quality model.

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The process phase involved gathering and analyzing data needed in developing the system, the actual system design with its hardware and software requirements, system testing, and system improvisation based on the assessments of IT experts and end-users. The process phase in the paradigm also shows that the hardware requirements for the development of the hydrophonic system include Arduino mega, relay, 12v fan, buzzer,

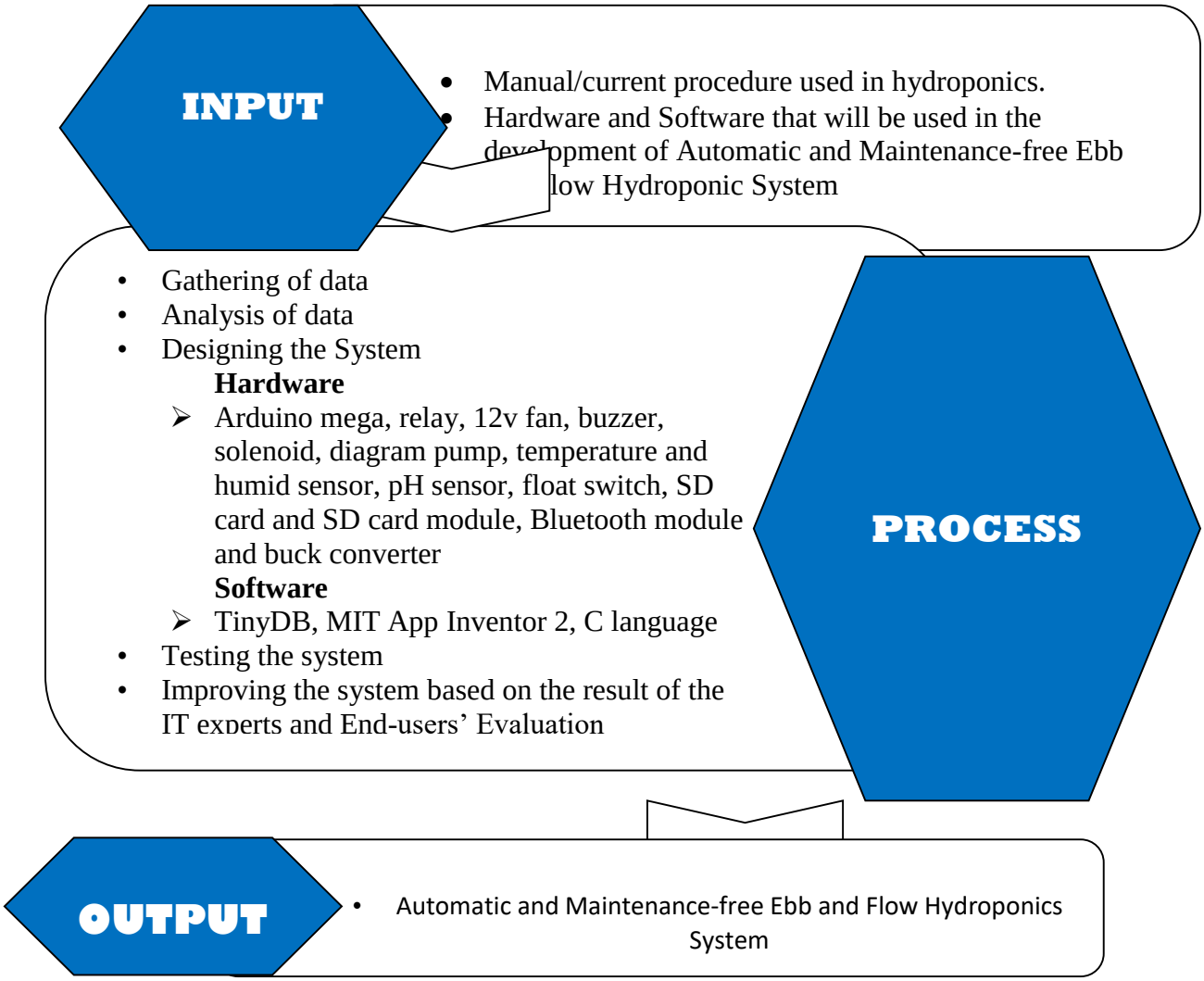


**Figure 1.** *Conceptual Paradigm of the Study*

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solenoid, diagram pump, temperature and humid sensor, pH sensor, float switch, SD card and SD card module, Bluetooth module and buck converter. On the other hand, it also shows that the software requirements include TinyDB, MIT App Inventor 2, C language.

On the other hand, the output phase presents the newly developed Automatic and Maintenance free Ebb and Flow Hydroponic System.

### Research Problem

1. How may the technical quality of the developed hydroponic system be described by IT experts based on the following ISO 25010 Software product quality standards:
   1.1 functional suitability;
   1.2 performance efficiency;
   1.3 compatibility;
   1.4 usability;
   1.5 reliability;
   1.6 security;
   1.7 maintainability; and
   1.8 portability?

## II. METHODOLOGY

### Location of the Research

The research was carried out at Talavera Senior High School, where the researcher works as a teacher. The mentioned school, which is located in Pag-asa District, Talavera, Nueva Ecija, was established in 2016 following the introduction of former President Benigno Aquino III's groundbreaking K-12 Basic Education Curriculum. It now employs 46 teachers and serves over 1300 students in grades 11 through 12.

The Technical-Vocational (Tech-Voc) track at Talavera Senior High School comprises of various strands such as Agriculture, Information and Communications Technology (ICT), Cookery, and Shielded Metal Arc Welding (SMAW). There is no place for students taking strands in agriculture to practice actual plant growth because the Talavera Senior High School has just two (2) buildings built on a limited space within the space for the Junior High School in Talavera National High School. As a result, the researcher, who is both a Tech-Voc teacher and an IT teacher, pursued the conduct of this research in order to enable Talavera Senior High School agriculture students and teachers to exercise their expertise despite the restricted space and resources available to them.

### Respondents of the Study

The constructed hydroponic system was evaluated by 25 responders in terms of functionality, usefulness, efficiency, dependability, portability, and maintainability. Five (5) of the respondents were IT experts, while the remaining 20 were end-users, including 15 agriculture

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students and five agriculture teachers. The responses served as a foundation for assuring that the produced hydroponic system meets the ISO 25010 Software product quality criteria.

The following table, Table 1, shows the distribution of the respondents:

**Table 1**

Distribution of Respondents

| Distribution of Respondents | Number of Respondents |
|---|---|
| **IT Experts** | 5 |
| **End-Users** | |
| -Agriculture students | 15 |
| -Agriculture teachers | 5 |
| **Total** | **25** |

**Sample and Sampling Procedure**

The researcher employed expert sampling, which is a sort of purposive selection, to pick the respondents who would participate in this study. Expert sampling entails taking samples from specialists in the topic under investigation. It is used when someone with a high level of understanding in a certain field, such as information technology, needs their opinion or assessment. The five (5) IT specialists who served as the initial group of evaluators were chosen via expert sampling.

On the other hand, the twenty end-users, consisting of fifteen (15) agriculture students and five (5) agriculture teachers, were purposefully picked because they were the system's direct users.

**Data Analysis Technique**

Because there was no statistical data involved in the process, data for the development stage of the Automatic and Maintenance-free Ebb and Flow Hydroponics System was thoroughly reviewed and given textually.

On the other hand, the data acquired during the end-users' evaluation of the produced hydroponic system's technical quality was statistically analyzed using weighted mean.

Furthermore, data from the expert evaluation stage was computed using weighted scores and weighted mean of the responses and assessed in relation to the various software criteria based on ISO 25010 Software Product Quality Standards.

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**Research Instrument**

The researcher employed ISO/IEC 25010 to evaluate the created autonomous and maintenance-free ebb and flow hydroponic system. To replace the ISO/IEC 9126 standard, the ISO/IEC 25010 standard was created in 2011. There are two sections to the ISO/IEC 25010: the quality in use model and the product quality model. The quality in use model is made up of five criteria that are related to the outcome of an interaction when a product is utilized in a specific environment. This system concept applies to the entire human-computer system, encompassing both current computer systems and software products. A product quality model, on the other hand, is made up of eight characteristics that relate to static software properties and dynamic computer system properties. Both computer systems and software products can benefit from the model. In general, the ISO/IEC 25010 product quality model was used to evaluate the developed system in this study, as indicated below.


**Figure 3.** ISO25010Software Product Quality Standards

A different set of research questionnaire was given to IT experts and end-users. IT experts were given a complete set of ISO 25010 Software Product Quality Standards specifically: functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. However, end-users were only given a questionnaire which includes only the three main characteristics provided by ISO 25010 Software Product Quality Standards namely: functional suitability, usability, and portability. This was due to the technicality of other ISO 25010 Software Product Quality Standards. Other characteristics such as performance efficiency, compatibility, reliability, security, and maintainability could only be correctly assessed by IT experts.

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The following scoring guide was used to interpret the data gathered in accordance to the given ISO 25010Software Quality Standards

**Table 2.**
Response Mode

| Standards | Range | Interpretations | Descriptor |
|---|---|---|---|
| **Functional Suitability** | **4** | Very Functional | Efficiently meets all the stated and implied needs; and no weaknesses are found. |
| | 3 | Functional | Satisfactorily meets all the stated and implied needs but acceptable / tolerable weaknesses are found which will however not affect its function |
| | 2 | Slightly Functional | Meets only some of the stated and implied needs and minor weaknesses are found that will slightly affect its function. |
| | 1 | Not Functional | Meets very few stated and implied needs; and major weaknesses are found that will greatly affect its function. |
| **Performance Efficiency** | **4** | Very Efficient | Efficiently performs all the stated and implied needs relative to the amount of resources without any flaws. |
| | 3 | Efficient | Satisfactorily performs all the stated and implied needs relative to the amount of resources used but tolerable flaws are found which will however not affect the MTA's over-all performance |
| | 2 | Slightly Efficient | Poorly performs the stated and implied needs relative to the amount of resources used and major flaws are found that will greatly affect its performance. |
| | 1 | Not Efficient | Does not perform the stated and implied needs relative to the amount of resources used. Thus, restructuring is needed. |

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|---|---|---|---|
| **Compatibility** | **4** | Very Compatible | Efficiently meets the required function while sharing the same hardware and software environment. It can exchange information with other systems with no inadequacies at all. |
| | 3 | Compatible | Satisfactorily meets the required function while sharing the same hardware and software environment. It can exchange information with other systems but tolerable inadequacies are found which will not in any way affect the MTA's over-all compatibility |
| | 2 | Slightly Compatible | Poorly performs the required function while sharing the same hardware and software environment. It can exchange information with other systems but major inadequacies are found that will greatly affect its compatibility. |
| | 1 | Not Compatible | Does not meet the required function while sharing the same hardware and software environment. It cannot exchange information with other systems thus restructuring is needed. |
| **Usability** | **4** | Very Usable | Provides a user interface that is easy to operate and control such that the users can effortlessly perform their appropriate needs even without guide or supervision. |
| | 3 | Usable | Provides a user interface that is easy to operate and control such that the users can easily perform their appropriate needs with minimal guide or supervision. |
| | 2 | Slightly Usable | Provides a user interface that is slightly difficult to operate and control such that |

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|---|---|---|---|
| | | | the users cannot easily perform their appropriate needs. |
| | 1 | Not Usable | Provides a user interface that is difficult to operate and control such that it is difficult for the users to perform their appropriate needs at all. Thus restructuring is required for the MTA |

| | | | |
|---|---|---|---|
| **Reliability** | **4** | Very Reliable | Efficiently performs its functions without failure under specified conditions and period of time with no flaws at all. |
| | 3 | Reliable | Satisfactorily performs its functions without failure under specified conditions and period of time with minimal flaws which will not in any way affect t the MTA's over-all reliability. |
| | 2 | Slightly Reliable | Performs only some its functions without failure under specified conditions and period of time with major flaws which will affect the MTA's over-all reliability. |
| | 1 | Not Reliable | Cannot perform any of its functions without failure under specified conditions and period of time, thus restructuring is required. |
| **Security** | **4** | Very Secured | Efficiently protects information and data with no weaknesses at all. |
| | 3 | Secured | Satisfactorily protects information and data with minimal weaknesses which will not in any way affect t the MTA's overall security. |
| | 2 | Slightly Secured | Protects only some of its information and data with major weaknesses which will affect the MTA's over-all security. |

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| | | | |
|---|---|---|---|
| | 1 | Not Secured | Cannot protect any information and data, thus restructuring is required. |
| **Maintainability** | **4** | Very Maintainable | Efficiently retains its original form and can be restored to that form in case of failure, with no weaknesses at all. |
| | 3 | Maintainable | Satisfactorily retains its original form and be restored to that form in case of failure; with minimal weaknesses, which however, will not affect its overall maintainability. |
| | 2 | Slightly Maintainable | Retains and restores only some of its original features in case of failure; with moderate weaknesses which may affect its over-all maintainability. |
| | 1 | Not Maintainable | Cannot retain and restore its original form in case of failure, thus restructuring is required. |
| **Portability** | **4** | Very Portable | Efficiently adapts to changes in environment and can be installed / uninstalled in specified environment, with no weaknesses at all. |
| | 3 | Portable | Satisfactorily adapts to changes in environment and can be installed / uninstalled in specified environment, with minimal weaknesses, which however, will not affect its overall portability. |
| | 2 | Slightly Portable | Barely adapts to changes in environment and can be installed / uninstalled in specified environment with moderate weaknesses which may affect its over-all portability. |
| | 1 | Not Portable | Cannot adapt to changes in environment and cannot be installed / uninstalled in specified environment. |

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To interpret the summary results of the assessment of the respondents with ISO 25010 criteria the following scoring guide was used.

**Table 3.**
Scoring Guide

| Range | Descriptors | Verbal Interpretation |
|---|---|---|
| 3.25 – 4.00 | Highly Functional/ Highly Efficient/ Highly Compatible/ Highly Usable/ Highly Reliable/ Highly Secured/ Highly Maintainable/ Highly Portable | Excellent |
| 2.50 – 3.24 | Functional/ Efficient/ Compatible/ Usable/ Reliable/ Secured/ Maintainable/ Portable | Very Good |
| 1.75 – 2.49 | Slightly Functional/ Slightly Efficient/ Slightly Compatible/ Slightly Usable/ Slightly Reliable/ Slightly Secured/ Slightly Maintainable/ Slightly Portable | Good |
| 1.00 – 1.74 | Not Functional/ Not Efficient/ Not Compatible/ Not Usable/ Not Reliable/ Not Secured/ Not Maintainable/ Not Portable | Poor |

**Data Gathering Procedure**

The sequence planning phase was followed by a system analysis to discover the system's nature and fundamental characteristics. The system's and program's building, coding, testing, and implementation were next, followed by the system's and program's maintenance requirements and considerations.

After the development process, the IT professionals evaluated the Ebb and Flow hydroponic system for functional adequacy, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability in requirements of ISO 25010 Software Product Quality Standards. End-users, on the other hand, determined the system's acceptability based on ISO 25010 standards for functional adequacy, usability, and portability.

## III. RESULTS AND DISCUSSIONS

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**Evaluation of IT experts on the developed automatic and maintenance-free Ebb and Flow hydroponics system**

The performance and the qualities of the developed automatic and maintenance-free Ebb and Flow hydroponics system were assessed by IT experts based on ISO 25010 Software Product Quality Standards namely: functional suitability, reliability, security, maintainability, and portability.

### 1.1 Functional Suitability

Table 1 shows the functional suitability of the developed hydroponics system as assessed by IT experts.

As shown on the table, the Functional Completeness and Functional Correctness of the developed system both obtained a weighted mean rating of 3.80, while Functional Appropriateness obtained a perfect 4.00. These figures only prove that as rated by the IT Experts, the developed system was excellent in terms of functional suitability. This implies that the IT experts recognized evidences of the quality they were looking for in the hydroponics system, with no error or revision, which means that the functions of the system are excellently complete, correct and appropriate, and therefore can be considered very functional as a whole.

**Table 1:**
Assessment of IT experts on the functional suitability of the system

| Functional Suitability | Mean | Verbal Description |
|---|---|---|
| 1. Functional Completeness | 3.80 | Very functional |
| 2. Functional Correctness | 3.80 | Very functional |
| 3. Functional Appropriateness | 4.00 | Very functional |
| **Overall** | **3.87** | Very functional |

Moreover, the overall weighted mean obtained on functional suitability was 3.87 with an interpretation of very functional. This clearly shows that the system provides functions that meet stated and implied needs when used under specified conditions. However, during the trial of the hydroponics system, IT experts had a hard time connecting the Bluetooth module to the arduino device; nonetheless, this problem was properly addressed by the researcher.

### 1.2 Performance Efficiency

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Shown on table 8 is the assessment of the IT experts on the functional efficiency of the developed hydroponics system.

As depicted on the table, the sub-characteristics of functional efficiency, namely: time behavior, resource utilization, and capacity, all obtained a mean of 3.60 with an interpretation of very efficient.

**Table 2:**
Assessment of IT experts on the functional efficiency of the system

| Performance Efficiency | Mean | Verbal Description |
|---|---|---|
| 1. Time Behavior | 3.60 | Very efficient |
| 2. Resource utilization | 3.60 | Very efficient |
| 3. Capacity | 3.60 | Very efficient |
| **Overall** | 3.60 | Very efficient |

Moreover, for the overall weighted mean in functional efficiency, the IT experts evaluated the developed Ebb and Flow hydroponics system as excellent. This shows that the device developed by the researcher was very efficient and excellently performed relative to the amount of resources used under stated condition. However, there were still issues encountered regarding command responsiveness. Whereas, the communication time between the Bluetooth device and the arduino device takes more time than expected, also the filling of water in the tank was a little slow because the diaphragm pump used to flood and drain water in hydroponics system only had the capacity of 1.5 to 2 liters per minute. However, the researcher discussed that the diaphragm used for the system was the most appropriate for the device as it only uses very low current but offer high capacity output.

### 1.3 Compatibility

Shown on table 3 is the assessment of the IT experts on the compatibility of the hydroponics system in terms of its two sub-characteristics. As shown on the table co-existence obtained a mean of 3.40 with an interpretation of very compatible. On the other hand, interoperability acquired a mean of 4.00 which also shows that the device was very compatible when it comes to interoperability. This clearly shows that all IT experts found the device excellent and very compatible when it comes to its interoperability or the device's ability to exchange information and use of information that has been exchanged.

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**Table 3:**
Assessment of IT experts on the compatibility of the system

| Compatibility | Mean | Verbal Description |
|---|---|---|
| 1. Co-existence | 3.40 | Very compatible |
| 2. Interoperability | 4.00 | Very compatible |
| **Overall** | 3.70 | **Very compatible** |

Moreover, the IT experts assessed the compatibility of the device as excellent, with an overall weighted mean of 3.70. It implies that the IT experts found the device very compatible and excellent in exchanging information with other components of the device and in performing its required functions, while sharing the same hardware or software environment. However, IT experts pointed out that the fast pace upgrades of smart phone's app and new hardware features might affect the compatibility of the automatic and maintenance-free Ebb and Flow hydroponics system's app, thus, emulator testing of the app and possible app modification was suggested.

### 2.4 Usability

Usability is seen as important measure among users particularly ease of use, conformance to user needs and satisfaction among users according to the findings of Javier(2019). Table 4 shows the assessment of the IT experts on the usability of the Ebb and Flow hydroponics system. As shown on the table, appropriate recognizability obtained a mean of 3.40 with an interpretation of very usable. Learnability acquired a mean of 3.80 which was also interpreted as very usable. This is the same with operability which also obtained a mean of 3.80. User error protection and user interface aesthetics both obtained a mean obtained of 3.60. Lastly, accessibility acquired a mean of 3.80.

**Table 4:**
Assessment of IT experts on the usability of the system

| Usability | Mean | Verbal Description |
|---|---|---|
| 1. Appropriateness recognisability | 3.40 | Very usable |
| 2. Learnability | 3.80 | Very usable |

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|---|---|---|
| 3. Operability | 3.80 | Very usable |
| 4. User Error Protection | 3.60 | Very usable |
| 5. User Interface Aesthetics | 3.60 | Very usable |
| 6. Accessibility | 3.80 | Very usable |
| **Overall** | 3.67 | **Very usable** |

Moreover, the IT experts assessed the overall usability of the developed automatic and maintenance-free Ebb and Flow hydroponic system as excellent with an overall weighted mean of 3.67. It can therefore be stated that the device was very usable.

In addition, the learnability, operability, and accessibility of the device got the highest mean, proving its excellence. Furthermore, the IT experts found the mobile application very easy to use. Users needed not to maintain the hydroponics system on a daily basis. All they needed to do was set up to their desired setting through the mobile app and they could use the default setting without trouble afterwards.

However, appropriateness recognisability obtained the lowest mean. According to the IT experts improvement in control interface was needed so that it would be easily understood by end-users. Also, additional tool tips and help icons were suggested.

### 2.5 Reliability

Table  shows the assessment of IT experts on the reliability of the developed Ebb and Flow hydroponics system. Reliability is the degree to which a system, product or component performs specified functions under specified conditions for a specified period of time.

As shown on the table, maturity obtained a mean of 3.60 with means that the device's maturity was very reliable. Availability obtained a mean of 3.00 which was only interpreted as reliable. Lastly, fault tolerance, and recoverability obtained a mean of 4.00 with an interpretation of very reliable.

**Table 5:**
*Assessment of IT experts on the reliability of the system*

| Usability | Mean | Verbal Description |
|---|---|---|
| 1. Maturity | 3.60 | Very reliable |

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| | | |
|---|---|---|
| 2. Availability | 3.00 | Reliable |
| 3. Fault Tolerance | 4.00 | Very reliable |
| 4. Recoverability | 4.00 | Very reliable |
| **Overall** | 3.65 | Very reliable |

Overall, the IT experts assessed the Ebb and Flow hydroponics system as excellent with an overall weighted mean of 3.65. This further means that the IT experts found the hydroponics system as very reliable under specified conditions for a specified period of time.

Nonetheless, the hydroponics system obtained the lowest assessment in terms of availability. This was mainly because some of the components in the hydroponics system were not accessible in local electronic supply stores. Some of the components were out of stock and were bought by the researcher online.

On the other hand, fault tolerance, and recoverability obtained the highest mean, whereas, according to the IT experts' assessment, the system operates as intended despite the presence of hardware or software faults.

### 2.6 Security

Shown on table 6 is the assessment of IT experts on the security of the automatic and maintenance-free Ebb and Flow hydroponics system. Security is the degree to which a product or system protects information and data so that persons or systems have the degree of data access appropriate to their types and levels of authorization.

As shown on the table, confidentiality as assessed by IT experts obtained a mean of 3.80 which means that the device was very secured when it comes to confidentiality. Integrity acquired a mean of 3.40 with an interpretation of very secured. Lastly, non-repudiation, accountability, and authenticity all got a mean of 3.60 which all had interpretation of very secured.

**Table 6:**
*Assessment of IT experts on the security of the system*

| Security | Mean | Verbal Description |
|---|---|---|
| 1. Confidentiality | 3.80 | Very secured |
| 2. Integrity | 3.40 | Very secured |

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| | | |
|---|---|---|
| 3. Non-repudiation | 3.60 | Very secured |
| 4. Accountability | 3.60 | Very secured |
| 5. Authenticity | 3.60 | Very secured |
| **Overall** | 3.60 | **Very secured** |

The overall mean acquired for security was 3.60. This means that IT experts assessed the security of the developed Ebb and Flow hydroponics system as excellent. This means that the control of the hydroponics system was very secured and exclusive to the user with correct password and mobile application. This was actually the reason why confidentiality obtained the highest mean among all the sub-characteristics of Security.

However, integrity got the lowest mean. As indicated by IT experts the device was still possible to be breached and can be penetrated due to the increasing adaptability of IT security challenges. Also, the device itself does not have anti-theft system, thus, the device cannot be tracked in case it was stolen. The researcher himself sees this as a major problem specifically because the school does not have its own gate and an body can freely enter the school premises.

### 2.7 Maintainability

Table 7 shows the assessment of IT experts on the maintainability of the developed automatic and maintenance-free Ebb and Flow hydroponics system. Maintainability represents the degree of effectiveness and efficiency with which the system can be modified to improve it, correct it or adapt it to changes in environment, and in requirements.

As shown on the table, modularity obtained a mean of 3.60 which means that the modularity of the device was very maintainable. Also reusability, analysability, and testability got a mean of 3.80 which was all very maintainable. Lastly, modifiability obtained a mean of 3.40 which was also interpreted as very maintainable.

**Table 7:**
*Assessment of IT experts on the maintainability of the system*

| Maintainability | Mean | Verbal Description |
|---|---|---|
| 1. Modularity | 3.60 | Very maintainable |
| 2. Reusability | 3.80 | Very maintainable |

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|---|---|---|
| 3. Analysability | 3.80 | Very maintainable |
| 4. Modifiability | 3.40 | Very maintainable |
| 5. Testability | 3.80 | Very maintainable |
| **Overall** | 3.68 | **Very maintainable** |

Moreover, the overall weighted mean obtained for maintainability was 3.68. This means that the IT experts saw the developed Ebb and Flow hydroponics system as excellent and very maintainable in all aspects.

### 2.8 Portability

Shown on table 8 is the assessment of IT experts on the portability of the developed automatic and maintenance-free Ebb and Flow hydroponics system. Portabilityis the degree of effectiveness and efficiency with which the system can be transferred from one hardware, software or other operational or usage environment to another.

As shown on the table, adaptability obtained a mean of 4.00 which means that the adaptability of the device was very portable. Instability acquired a mean of 3.60 which was also interpreted as very portable. Lastly, replaceability was also interpreted as very portable with a mean of 3.80.

**Table 8:**
*Assessment of IT experts on the portability of the system*

| Portability | Mean | Verbal Description |
|---|---|---|
| 1. Adaptability | 4.00 | Very portable |
| 2. Instability | 4.00 | Very portable |
| 3. Replaceability | 3.80 | Very portable |
| **Overall** | 3.93 | **Very portable** |

Overall, the weighted mean obtained for portability was 3.93 which means that the IT experts perceived that the device developed was very portable. This clearly shows that IT experts saw the efficiency of the hydroponics system, and the hardware and software can be easily transferred to other environment. It experts perfect assessment for the device's adaptability, and instability clearly shows the flexibility of the hydroponics system. Whereas, it can be installed and

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operated using any other android phones. It can also be operated using non-android operating system such as windows devices with installed emulator.

Nonetheless, IT experts still gave a lower score to the device's replaceability. This was because the researcher had not tried other programming software aside from the Arduino integrated development environment (IDE).

## Conclusions

IT experts assessed or evaluated successfully the Automatic and Maintenance-Free Ebb and Flow Hydroponics System as excellent in all ISO 25010 Software Product Quality Standards.

## Recommendations

1. Other researchers could replicate the study. The study could also be replicated using a larger set of respondents over a longer span of time in order to attain more definite results.
2. Future researchers could try to replicate this study using other type of hydroponics system.

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