Article
Infosphere Is Reshaping: How the Internet of Things Leads Smart Campuses for Knowledge Management

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Abstract: This article gauges Saudi universities’ readiness to integrate the Internet of Things (IoT) in knowledge management (KM) and identifies the challenges relating to its use. A descriptive-analytical approach was used to discuss the concepts, development, and general structure that characterize the IoT and its related challenges and to find ways to address them. This study used a three-axis questionnaire, which was applied to 275 faculty members and information technology officials in Saudi universities. The results revealed that a strategy related to the development of infrastructure and the provision of equipment and applications to deal with and analyze big data is needed, besides the conviction of the faculty and specialists in its potential in developing the teaching and learning environment in universities and providing unique research by interlinking the network of laboratories and research and training laboratories. The results also revealed that its effects on the university learning environment are gender, rank, and experience agonistic. Finally, 12 main criteria and 44 sub-applications were reached to manage the smart campus’s information generated by the IoT.

Keywords: Internet of Things (IoT); knowledge management (KM); infosphere; smart campus; knowledge universities; university learning environment (ULE)

1. Introduction

The technological revolution has led to the creation of knowledge-based societies, where countries’ progress is measured by the extent to which they use and employ communication and information technologies in the provision of services. Thus, ICT has become the main driver of many transformations that enable individuals to obtain services. Every society needs to enable its generations to learn ICT skills to face rapid changes related to the education process, evolved by big data, the IoT, learning analytics, and data mining.

Many educational institutions are beginning to realize the importance of integrating the IoT into their educational methods and management in tracking key resources [1], creating smarter educational plans, security, and enhancing access to information [2].

The IoT is a rapidly growing network of “connected things,” which improves both the teaching-learning process and educational institutions’ infrastructure [3]. IoT technology improvement enhances school, college, and university teaching [4,5], from student to teacher, classroom to campus, etc.

The IoT comprises enabling communication between things and entities with humans within the framework of Internet services by availing components that ensure the distinction of each item through sensors and data transmission via networks with advanced specifications and protocols [4,6,7].
Knowledge has become the most vital resource to organizations, evident in the concepts of KM and the realization of the resources in knowledge production, organization, and sharing. With the advancement of the IoT and the development of information and communication technologies, they can synergize with knowledge management [8]. Knowledge is the basis for the organizational decision-making of universities, making knowledge a fixed asset. Universities can utilize explicit knowledge within organized structures, enhancing learning mechanisms and competencies, and building valuable capabilities.

Knowledge management consists of strategies and policies that maximize information resources and guide them to serve an organization’s objectives, which improves creativity and decision-making [9]. Trees [10] and Rot and Sobinska [11] found that KM can utilize and benefit from the IoT in expediting data circulation.

The IoT is likely to revolutionize universities’ digital services. It is important to study this technology to enhance universities’ visions toward planning for the implementation and development of knowledge management services, which is doable through connecting objects and entities and making them available to students and faculty members. It also shows the importance of the study in working on a proposed conception of a model for integrating the IoT into a university’s knowledge management, which may raise the performance of knowledge management services within the university.

An unstructured interview was conducted to identify the problem with 60 students from some Saudi universities and 15 faculty members, and the interviews concluded the following: there are challenges in managing information and knowledge at Saudi universities efficiently and unfamiliarity with how to integrate the IoT into university knowledge management. In addition, interviewees stressed that there is no perception of integrating the IoT in the university.

Experts anticipate that the IoT will change how universities operate and revolutionize teaching, mentoring, learning, management, follow-up, communication, and self-service. It will even be able to connect all parties to the digital network, which means that it can be monitored remotely even after the completion of studies and graduation.

Based on the interviews, the research team analyzed studies that clarified the IoT’s mechanisms and their effects on measuring, deducing, and understanding environmental indicators in both vital environments and natural resources. The spread of these technologies in communication networks supported the perception of the IoT, information sharing across platforms, and compatibility with a variety of wireless communication and ICT technologies [12,13]. Per Hoy [14] and Al-Farsi [15] claim that despite the common use of the concepts of the IoT, they are still not vivid. Gul et al. [5] identified the nature of the IoT, its problems, and the mechanisms that can be adopted to achieve optimum use. The studies [16,17] included many services compatible with IoT applications.

Al-Salmi and Kahlert [7,18] assert that the use of IoT applications will support the provision of accurate information and knowledge; Sobinska and Rot [10] emphasized the potential offered by the IoT to improve data generation, processing, and transmission.

Hence, it is clear that universities are facing many difficulties related to KM efficiency due to not keeping pace with current technological developments. Besides, the failure of traditional means—even digital ones—to provide reliable KM services affects performance rates and knowledge circulation in universities.

Thus, the importance of this study is to (1) identify the concept of the Internet of Things, its mechanisms of action, the scope of its applications in the university environment, and its relationship to knowledge management; (2) to explore the challenges facing the use of the Internet of Things in Saudi universities; (3) to identify if there are differences in the effects of the Internet of Things on ULE among faculty members in Saudi universities due to variables (gender, academic rank, or experience).
2. Literature Review

2.1. What Is the IoT?

The Internet of Things is a network for exchanging information and the use of devices and systems connected to artificial intelligence to obtain data collected by sensors embedded and operating in machines, devices, and physical objects. The IoT uses communication media with minimal direct human intervention [19]. It can be defined as “a trend that includes linking a large number of devices called ‘smart entities’” that have the elements of employing and using communication services according to the protocols of the global network IPV6, and in which the human element does not directly interfere in its operation [5,10].

IoT-based systems communicate through wireless technologies like RFID (radio-frequency identification), Zigbee, NFC (near-field communication), WSN (wireless sensor network), WLAN (wireless local area network), DSL (digital subscriber line), UMTS (Universal Mobile Telecommunications System), WiMax (Worldwide Interoperability for Microwave Access), GPRS (General Packet Radio Service), or LTE (Long-Term Evolution) [20]. It is an extension of the Internet-based network, which extends human-to-human (H2H), human-to-thing (H2T), and object-to-thing (T2T) connectivity [19,21].

There are three basic components of the IoT: (1) hardware: sensors, actuators, and embedded communication devices; (2) middleware: tools for on-demand storage and computing; (3) presentation: new easy-to-understand visualization and interpretation tools that are accessible on different platforms [21,22]. The IoT links to smart learning environments in six main areas: (1) human-centered design, (ii) learning and working methods, (iii) learning and organization culture, (iv) smart IT infrastructure, (5) digital and physical equipment, and (6) engineering of the workplace [16,23,24].

2.2. IoT’s Impact on Universities

The IoT brings enormous challenges and opportunities to higher education, such as the unique growth of ubiquitous computing, cloud computing, big data, and learning analytics to improve targeted learning outcomes and research quality, develop the IoT community, and encourage a new digital culture. Moreover, it avails opportunities for online degrees and easy access to educational content in both structured and unstructured formats. The IoT is leading higher education institutions in radically transforming the traditional educational model while integrating broader disciplines, enriching big data’s value, and providing numerous research opportunities [24,25].

Mohanty, Al-dowah et al., and Bayani-Abbasy et al. [24,26,27] identify the most important IoT influences in higher education as follows: (1) engaging in the learning process; (2) fostering creativity; (3) intelligence and object interaction; (4) big data-related research opportunities; (5) intelligently accomplishing collaborative tasks; (6) hyper-connectivity amidst academies, institutes, and research centers. Cisco classifies IoT applications in digital campuses into five categories: building control and management, security and access control, video and information system management, location and attendance systems, and energy monitoring and control [28]. The IoT can improve classroom learning preparation, learning resources, methods, techniques, and management standards and costs. Zhu and Liang, Qin, Bayani-Abbasi et al., and Lovell [16,23,27,29] define the most important areas of IoT application in (1) virtual poster boards, (2) interactive knowledge acquisition, (3) live notifications, bulletin features, security and security indicators, (4) attendance and leave monitoring system and identification of vital student records, (5) face recognition, (6) and intelligent identification technology.

The research team summarizes this in Figure 1:
2.3. Challenges of Integrating the IoT into Higher Education

The key challenges to the IoT include security and privacy, availability, mobility, reliability, performance, interoperability, scalability, trust, and management, where the IoT connects the digital world and the physical world. It will be difficult to estimate the technological changes and challenges that it causes since data processing is the most important challenge in the IoT; there is a presence of large amounts of unauthorized data structured in real-time (resulting from the increasing use of LMS). Besides, it is challenging to transfer these data in real-time to obtain effective results through intelligent management [26,30]. Higher education also needs to develop standards to secure IoT applications and develop digital pedagogy, training, and interdisciplinary research to address cybersecurity issues and privacy expectations [26,30,31].

2.4. Smart Learning Environment

This is a type of advanced learning in which almost all objects in the process intelligently interact with each other. Smart learning environments (SLEs) are physical spaces enhanced with specific digital and contextual components (sensors and actuators) that facilitate better and faster learning, which allows learning approaches hybrids that switch between formal and informal settings, independent and classroom learning, different learning times and places, and analog and digital learning formats [32]. Table 1 distinguishes between digital and smart campuses [21,28]:

| Table 1. Digital and smart campuses. |
|------------------------------------|
| **Digital Campus** | **Smart Campus** |
| Technical environment | Local network–Internet | IoT–cloud computing–wireless network–mobile terminal |
| Application | Distant learning–digital learning resources–administrator of network | The smartness of sensory ability–interoperability–control capabilities |
| Management system | Isolated system | System sharing–intelligent push |

2.5. Knowledge Management

It is the application of management functions such as planning, organizing, controlling, and directing to benefit from the working environment’s knowledge of the organization...
represented in tacit and explicit knowledge through the processes and stages of knowledge development represented in obtaining, organizing, storing, applying, sharing, and benefiting from knowledge [33]. KM consists of “systematic processes or a set of practices used by organizations to identify, record, store, create, represent, distribute and represent knowledge for use, awareness, and education in other parts of the organization” [34].

Knowledge management has been hailed as one of the most significant advances in information studies and management science in recent decades. Knowledge management enables today’s complex organizations to make better decisions and solve problems more effectively by capturing, organizing, documenting, and sharing organizational knowledge. Universities, as the highest centers of learning, must build information infrastructure and foster an environment in which teaching and non-teaching staff, students, researchers, patrons, and other stakeholders can participate in various knowledge management activities [35].

2.6. Knowledge Management in Universities

Academic institutions, particularly higher education institutions such as universities, are viewed as “knowledge centers”, where a variety of activities are carried out for the development, preservation, distribution, and application of knowledge. Teachers, students, and researchers are all essential components of academic institutions, and they are all involved in the aforementioned tasks.

Knowledge management has been heralded as one of the most significant advances in information studies and management science in recent decades. Information management enables today’s complex companies to make better decisions and handle problems more effectively by capturing, organizing, documenting, and sharing organizational knowledge. Universities, as the highest centers of learning, must construct information infrastructure and foster an environment in which teaching and non-teaching personnel, students, researchers, patrons, and other stakeholders can participate in diverse knowledge management activities.

2.7. KM and the IoT

The possession of knowledge is one of the most important and seekable resources by organizations, especially universities, which have begun to realize the importance of adopting the concept of knowledge management and investing in it to transform into knowledge universities. This happens through the role played by the human element related to this knowledge through the processes associated with its production, organization, and sharing, which contributes to improving its activities and services [6]. Connecting physical objects to the Internet allowed the creation of the Web of Things (WoT), which provided interfaces for searching and data mining to discover and classify patterns. Through the WoT, knowledge can be categorized to create a direct link between everything physical and virtual. Universities are linked to knowledge management through [1,33].

Contributions of knowledge to the transformation into knowledge societies bring about adaptation to rapid change and face increasing complexity.

Universities view knowledge itself as a commodity to invest in economically, to create and sustain competitive advantage among universities.

Knowledge allows us to focus on the most innovative departments and spurs continuous innovation.

It can be said that intelligent information institutions can carry out processes of understanding knowledge and transform it from tacit to explicit knowledge within organized structures and then into an asset that constitutes its competitiveness as long as it possesses learning mechanisms and competencies and builds valuable capabilities [8].

The IoT will contribute to the production of knowledge in smart universities and integration within the framework of open systems in all aspects of decision-making and knowledge management, allowing knowledge exchange and sharing [27].
The Internet of Things plays a major role in managing knowledge and transforming a university environment into a smart one. The most important tools that need to be used are:
- Communication networks and protocols linked to an open data platform (cloud).
- Artificial intelligence technology and big data that can analyze data.
- Algorithm-based software and applications [27].
- In addition, the Internet of Things in the university environment is able to perform a set of tasks for knowledge management, including:
  - The Internet of Things can reduce the number of employees who perform some administrative tasks, such as data entry for absence systems, or payroll, which improves performance and reduces effort.
  - It can provide SMS services to inquire about any information and respond to it automatically
  - It automatically controls electrical energy resources and reduces waste in offices, laboratories, and classrooms, as this energy works when needed.

This study, therefore, endeavors to answer the following research questions:
- What is the level of readiness of the Saudi universities to integrate the IoT into KM?
- What are the expected impacts of the IoT on the ULE?
- What are the challenges facing the use of the IoT in universities?
- Are there differences in the effects of the Internet of Things on ULE among faculty members in Saudi universities due to the variable (gender, academic rank, or experience)?
- What are the criteria for integrating the IoT into the smart campus for KM?

The following sections present the research method as described, and are followed by the results of data analysis. Discussions and implications are taken up in the final sections of the paper.

3. Materials and Methods
3.1. Study Approach
The study was based on the analytical descriptive approach as the optimal approach to preparing the theoretical framework, focusing on the mechanisms of analysis and foresight, knowledge of reality, and trends in addressing global relations experiences in the use of applications of the Internet of Things through a quantitative approach [34]. This was represented by a questionnaire adopted by the research team and based on a reexamination of the theoretical framework and literature to develop a proposed scenario. Steadman and Adams [36] stated that this approach is appropriate for such a study.

3.2. Participation
The study population consisted of university faculty members, Internet of Things experts, and knowledge management officials at Saudi universities, where the study sample consisted of faculty members specializing in the Internet of things and knowledge management officials in nine Saudi universities (275 members of the faculty and IT officials in the Kingdom of Saudi Arabia), which is shown in Table 2.

Table 2 shows the distribution of the study sample members according to the universities to which the faculty member belongs, gender, academic rank, and number of years of experience. The majority came from King Fahd University of Petroleum and Minerals with 9.09%, followed by Qassim and Al Baha University with 8.3%, and Princess Nourah Bint Abdul Rahman University with 8%. The relative majority of the total study sample members were males with 70.5%, whereas females were 29.5%. The relative majority of the scientific rank variable came in favor of assistant professors with 77.09%. Participating professors were 32.1%, consisting of 26 members, and professors were 24.7%, consisting of 20 members. The majority of the number of years of experience was from the category of 15 years to less than 20 years, with 38.3%, consisting of 31 members, followed by the category of 10 years to less than 15 years, with a rate of (22.2%).
Table 2. Shows the distribution of the quantitative study sample.

| Variables                                             | Number of Participants | Percentages |
|-------------------------------------------------------|------------------------|-------------|
| 1 Hail University                                    | 15                     | 5.45%       |
| 2 King Fahd University of Petroleum and Minerals      | 25                     | 9.09%       |
| 3 King Khalid University                             | 21                     | 7.6%        |
| 4 Umm Al Qura University                             | 19                     | 6.9%        |
| 5 Imam Muhammad Bin Saud Islamic University           | 12                     | 4.3%        |
| 6 Al Qussaim University                               | 23                     | 8.3%        |
| 7 King Saud University                                | 20                     | 7.2%        |
| 8 King Abdulaziz University                          | 17                     | 6.1%        |
| 9 King Faisal University                              | 15                     | 5.45%       |
| 10 Al Baha University                                | 23                     | 8.3%        |
| 11 King Abdullah University of Science and Technology | 9                      | 3.2%        |
| 12 Imam Abdul Rahman bin Faisal University            | 10                     | 3.6%        |
| 13 Al Jouf University                                | 12                     | 4.3%        |
| 14 Najran University                                 | 15                     | 5.45%       |
| 15 Princess Nora bint Abdurrahman University          | 22                     | 8%          |
| 16 Prince Sattam bin Abdulaziz University             | 17                     | 6.1%        |
| **Total**                                             | **275**                | **100%**    |

| Sex          |                  |               |
|--------------|------------------|---------------|
| Male         | 81               | 29.5%         |
| Female       | 194              | 70.5%         |
| **Total**    | **275**          | **100%**      |

| Academic Rank |                  |               |
|---------------|------------------|---------------|
| Professor     | 8                | 2.9%          |
| Associate Professor | 55 | 20%      |
| Assistant Professor | 212 | 77.09%  |
| **Total**     | **275**          | **100%**      |

| Years of Experience |                  |               |
|---------------------|------------------|---------------|
| From 5 years to less than 10 years | 168 | 61.09% |
| From 10 years to less than 15 years | 62  | 22.5%  |
| From 15 years to less than 20 years | 35  | 12.7%  |
| From 20 years and over           | 10   | 3.6%   |
| **Total**                       | **275**         | **100%**      |

3.3. Study Tools

The questionnaire was prepared according to the following scientific bases.

Building the e-Questionnaire

The questionnaire was designed based on the subject of the study, its objectives and questions, the nature of the data and information desired to be obtained, and reviewing the literature and previous studies. The questionnaire items were formulated from analyzing the goals and philosophy of the IoT and knowledge management (KM) per [5, 20, 21, 24, 27, 33] and were presented to the experts, who validated it 100%. Then, it was programmed through Google Drive. It was built to include primary data and three main axes: the first is the extent of the university’s readiness to integrate the IoT into knowledge management (20 items). The second included the IoT’s effects on the learning environment (20 items). The third identified the challenges of integrating the IoT into universities (17 items).

The questionnaire became an e-questionnaire consisting of three axes and 57 paragraphs to know the reality of using the Internet of Things, the most important devices, equipment, software, and infrastructure that can be combined with it, along with the opinions of experts.

The participants in the first axis were asked to determine the extent to which Saudi universities are prepared to integrate the Internet of Things into knowledge management from their point of view: “Highly available”, “available”, “available in a few number”, “nothing”, or “I don’t know”. This consists of 20 statements on a five-point Likert scale using a scale from one “Highly available” to five “I don’t know”.
In the second axis, the participants were asked to determine the degree of the expected effects of the Internet of Things on the university’s educational environment by choosing “high” to “weak.” This part consists of 20 statements on a three-point Likert scale using a scale from one (high) to five (weak).

In the third axis, they were asked to determine the degree of challenges facing the use of the Internet of Things in Saudi universities if they believed that these challenges were “very high, high, medium, low, or weak.” This part consists of 17 statements on a three-point Likert scale using a scale from one (large) to five (weak).

### 3.4. The Validity

The first axis was distributed to a survey sample (50) of faculty members and experts from the research community. Excluded from the basic research sample, the correlation coefficients of the scale items with the total score were extracted. The scale items were analyzed and the discrimination coefficient for each item was calculated. The coefficient of distinction here represents a sign of validity for each item in the form of a correlation coefficient between each item and the total score, and between each item and its link to the axis to which it belongs, besides the effect between each axis and the total score. The correlation coefficients of the paragraphs with the axis ranged from 0.51–0.87, and with the tool as a whole, ranged from 0.46–0.87, as shown in Table 3.

#### Table 3. The values of the correlation coefficients between the questionnaire paragraphs and the axis to which it belongs on the one hand, and the total score with the questionnaire on the other hand.

| No. of Item | Correlation Coefficient with the First Axis | Correlation Coefficient with the Tool | No. of Item | Correlation Coefficient with the Second Axis | Correlation Coefficient with the Tool |
|-------------|-------------------------------------------|--------------------------------------|-------------|---------------------------------------------|--------------------------------------|
| 1           | 0.70                                       | 0.53                                 | 10          | 0.70                                        | 0.53                                 |
| 2           | 0.76                                       | 0.65                                 | 11          | 0.50                                        | 0.65                                 |
| 3           | 0.66                                       | 0.46                                 | 12          | 0.66                                        | 0.46                                 |
| 4           | 0.70                                       | 0.53                                 | 13          | 0.82                                        | 0.55                                 |
| 5           | 0.66                                       | 0.46                                 | 14          | 0.82                                        | 0.55                                 |
| 6           | 0.51                                       | 0.73                                 | 15          | 0.59                                        | 0.73                                 |
| 7           | 0.48                                       | 0.49                                 | 16          | 0.73                                        | 0.59                                 |
| 8           | 0.62                                       | 0.78                                 | 17          | 0.83                                        | 0.74                                 |
| 9           | 0.82                                       | 0.55                                 | 18          | 0.48                                        | 0.49                                 |
| 10          | 0.70                                       | 0.53                                 | 19          | 0.70                                        | 0.53                                 |
| 11          | 0.76                                       | 0.65                                 | 20          | 0.71                                        | 0.87                                 |
| 12          | 0.66                                       | 0.46                                 | 13          | 0.70                                        | 0.53                                 |
| 14          | 0.87                                       | 0.49                                 | 2           | 0.76                                        | 0.65                                 |
| 15          | 0.83                                       | 0.74                                 | 3           | 0.60                                        | 0.54                                 |
| 16          | 0.48                                       | 0.49                                 | 4           | 0.70                                        | 0.53                                 |
| 17          | 0.70                                       | 0.53                                 | 5           | 0.50                                        | 0.65                                 |
| 18          | 0.66                                       | 0.46                                 | 6           | 0.70                                        | 0.53                                 |
| 19          | 0.51                                       | 0.73                                 | 7           | 0.62                                        | 0.78                                 |
| 20          | 0.48                                       | 0.49                                 | 8           | 0.76                                        | 0.65                                 |
| No. of Item | Correlation Coefficient with the Second Axis | Correlation Coefficient with the Tool | No. of Item | Correlation Coefficient with the Third Axis | Correlation Coefficient with the Tool |
|-------------|-------------------------------------------|--------------------------------------|-------------|---------------------------------------------|--------------------------------------|
| 1           | 0.60                                       | 0.54                                 | 10          | 0.70                                        | 0.53                                 |
| 2           | 0.70                                       | 0.53                                 | 11          | 0.66                                        | 0.46                                 |
| 3           | 0.50                                       | 0.65                                 | 12          | 0.66                                        | 0.52                                 |
| 4           | 0.70                                       | 0.53                                 | 13          | 0.48                                        | 0.49                                 |
| 5           | 0.62                                       | 0.78                                 | 14          | 0.70                                        | 0.53                                 |
| 6           | 0.70                                       | 0.53                                 | 15          | 0.59                                        | 0.87                                 |
| 7           | 0.66                                       | 0.46                                 | 16          | 0.87                                        | 0.49                                 |
| 8           | 0.51                                       | 0.73                                 | 17          | 0.83                                        | 0.74                                 |
| 9           | 0.48                                       | 0.49                                 |             |                                             |                                      |
From Table 3, all the correlation coefficients were acceptable and statistically significant, so none of these items were deleted. As for the correlation coefficients between the dimensions with each other and the tool as a whole, they are represented in Table 4.

Table 4. The values of the correlation coefficients between the axes of the research tool to each other and the tool as a whole.

| The Axes       | The First Axis | The Second Axis | The Third Axis | The Tool as a Whole |
|----------------|----------------|-----------------|----------------|---------------------|
| The first axis | 1.0            | 0.87 **         | 0.69 **        | 0.88 **             |
| The second axis| 1.0            | 0.64 **         | 0.86 **        |                     |
| The third axis | 1.0            |                 | 0.90 **        |                     |
| The tool as a whole | 1.0          |                    |                |                     |

** Statistically significant at the significance level (0.01).

3.5. Stability

After judging the tool and reaching its final image, the research team made sure of the stability of the tool. Using the test–retest method, it was distributed into a sample of 50 faculty members and experts outside the basic research sample twice, separated by two weeks, and the Pearson correlation coefficient was calculated between the two applications, as well as the stability (internal consistency) for the paragraphs using Cronbach’s alpha. The overall stability was 0.90, and the total stability coefficient was 0.91, as shown in Table 5, which were acceptable:

Table 5. Internal consistency coefficient, Cronbach’s alpha, repetition stability of axes, and total score.

| The Axes       | Repetition Stability (Pearson Correlation Coefficient) | Internal Consistency (Cronbach’s Alpha) |
|----------------|--------------------------------------------------------|----------------------------------------|
| The first axis | 0.92                                                   | 0.85                                   |
| The second axis| 0.86                                                   | 0.88                                   |
| The third axis | 0.93                                                   | 0.94                                   |
| The tool as a whole | 0.90                                          | 0.91                                   |

4. Results

4.1. Answer of Question 1

To answer 1st Q:

The averages and standard deviations of the sample answers were calculated on the axis of the questionnaire: the extent of readiness of Saudi universities to integrate the Internet of Things into knowledge management as shown in Table 6.

As per Table 6, the general arithmetic mean of the sample responses on the first axis is 2.40, which is an indication that there is an agreement with the degree of readiness (Nothing) on the items of the questionnaire about IoT’s effects on the ULE. In the first axis, the value of the standard deviation of the general mean of the axis is 0.662, indicating the great homogeneity between the sample responses about the identification of IoT’s effects on the ULE in the axis of Saudi universities’ readiness to integrate the IoT into KM.

Table 6 shows that the means of the axis items ranged from 3.37–1.58, where the item “The university is characterized by the presence of low-energy variants of Bluetooth, Wi-Fi, and NFC” had the highest mean of 3.37 and the degree of readiness (available). The item “The university is distinguished by the presence of good data encryption mechanisms and how to securely preserve them and the means of effective transportation and messaging” was with a mean of 3.09 in the second place with a degree of readiness (available in few numbers).
Table 6. Means and standard deviations of questionnaire items Axis 1: extent of readiness of Saudi universities to integrate the IoT in knowledge management, in descending order.

| Rank | No. | Items                                                                                                                                                                                                 | Mean  | Standard Deviation | Degree of Readiness |
|------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------------|---------------------|
| 1    | 15  | The university features the low-energy variants of Bluetooth, Wi-Fi, and NFC.                                                                                                                             | 3.37  | 0.966               | Available           |
| 2    | 19  | Good data encryption mechanisms distinguish the university, secure it, and effective means of transportation and messaging.                                                                           | 1.220 | 3.09                | Available in a few numbers |
| 3    | 10  | The presence of data storage distinguishes the university: it stores data for IoT devices.                                                                                                             | 2.93  | 0.960               | Available in a few numbers |
| 4    | 11  | The university is characterized by networking (the Internet connection layer that enables entities to communicate with their devices and enables devices to communicate with each other). | 2.79  | 1.264               | Available in a few numbers |
| 5    | 12  | The university has on-demand storage and computing tools for data analysis.                                                                                                                                | 2.73  | 1.277               | Available in a few numbers |
| 6    | 13  | The university is distinguished by the presence of microchips for wireless data communications.                                                                                                        | 2.51  | 1.349               | Available in a few numbers |
| 7    | 9   | The university has analytics systems (software systems that analyze data generated by IoT devices).                                                                                                        | 2.51  | 1.176               | Available in a few numbers |
| 8    | 3   | The university has an IoT ecosystem (the components that enable students and employees to connect to their IoT devices, including remote controls, control panels, networks, portals, analytics, data storage, and security). | 2.50  | 0.732               | Available in a few numbers |
| 9    | 5   | The university is distinguished by the presence of the network layer (responsible for transmitting the data collected by the physical layer to different devices).                                           | 2.50  | 0.983               | Available in a few numbers |
| 10   | 8   | The university is distinguished by the presence of a control panel (it displays information about the IoT ecosystem to users and allows them to control it remotely).                                       | 2.50  | 0.979               | Available in a few numbers |
| 11   | 4   | The university has a physical layer (represented in the IoT device’s devices, including sensors and network equipment).                                                                               | 2.36  | 0.813               | Nothing             |
| 12   | 2   | The university is distinguished by the presence of IoT devices (i.e., a device connected to the Internet and can be monitored or controlled remotely).                                                     | 2.30  | 0.879               | Nothing             |
| 13   | 1   | The university has a network of internet-connected objects that can collect and exchange data using built-in sensors.                                                                                 | 2.29  | 0.960               | Nothing             |
| 14   | 20  | Platforms: they represent the middleware that is used to connect all entities to the IoT.                                                                                                              | 2.22  | 1.145               | Nothing             |
| 15   | 6   | The university has the application layer (the protocols and interfaces that devices use to recognize and communicate with each other).                                                              | 2.14  | 0.992               | Nothing             |
| 16   | 7   | The university is characterized by the presence of remote control devices (which enable entities that use Internet of Things devices to connect to and control them using a control panel as a mobile application, and they include smartphones, tablets, computers, smartwatches, and connected TVs. | 2.07  | 0.885               | Nothing             |
| 17   | 14  | The university has sensors and sensors that can receive accurate internet data.                                                                                                                            | 2.01  | 1.002               | Nothing             |
| 18   | 17  | The university has sensors installed on devices and objects.                                                                                                                                           | 1.86  | 0.918               | Nothing             |
| 19   | 18  | The university has protocols designed for this purpose, such as Zigbee.                                                                                                                                 | 1.72  | 1.038               | I don’t know        |
| 20   | 16  | The university is distinguished by the presence of radiofrequency (RFID) that is used at the university.                                                                                                   | 1.58  | 0.910               | I don’t know        |

The first axis: how ready is the University of Hail to integrate the IoT into knowledge management.
Although the item “The university is characterized by the presence of radio frequency (RFID) that is used in the university” came with the lowest mean (1.58), and the degree of readiness “I don’t know”, the results indicated that the rest of the items of the axis came with a degree of readiness (“available in few numbers” to “I don’t know”).

This shows that there is a need to develop the infrastructure to integrate the IoT and to effectively integrate them.

4.2. Answer of Question 2

To answer 2nd Q:

As in Table 7, the means and standard deviations of the sample responses to the questionnaire were calculated in the axis: IoT’s effects on the ULE.

Table 7: Means and standard deviations of the questionnaire items/the second axis: the effects of the IoT on the ULE in descending order.

| Rank | No. | Items                                                      | Mean  | Standard Deviation | Impact Degree |
|------|-----|------------------------------------------------------------|-------|--------------------|---------------|
| 1    | 2   | Research opportunities                                     | 4.71  | 0.453              | Very high     |
| 2    | 3   | Smart e-learning                                          | 4.64  | 0.480              | Very high     |
| 3    | 1   | Engaging in the learning process                          | 4.63  | 0.477              | Very high     |
| 4    | 20  | Laboratories and research and training laboratories       | 4.62  | 0.480              | Very high     |
| 5    | 5   | Super connect                                             | 4.61  | 0.551              | Very high     |
| 6    | 14  | Scientific research                                       | 4.60  | 0.614              | Very high     |
| 7    | 12  | Big data                                                  | 4.58  | 0.611              | Very high     |
| 8    | 17  | Constant contact with things and people                   | 4.57  | 0.495              | Very high     |
| 9    | 4   | Smart collaboration                                       | 4.56  | 0.478              | Very high     |
| 10   | 7   | Scalability                                               | 4.55  | 0.496              | Very high     |
| 11   | 10  | Cognitive aspects                                         | 4.53  | 0.626              | Very high     |
| 12   | 9   | Performance rate (student and teacher)                    | 4.50  | 0.401              | Very high     |
| 13   | 18  | Efficient resource management and rationalization of      | 4.50  | 0.501              | Very high     |
|      |     | expenditures                                               |       |                    |               |
| 14   | 19  | Libraries                                                 | 4.88  | 0.501              | Very high     |
| 15   | 6   | Self-education                                            | 4.43  | 0.728              | Very high     |
| 16   | 16  | The ability to predict behaviors and needs                 | 4.42  | 0.626              | Very high     |
| 17   | 15  | Entertainment activities                                  | 4.41  | 0.625              | Very high     |
| 18   | 8   | Learning objects                                          | 4.29  | 0.701              | Very high     |
| 19   | 13  | Ultra-security                                            | 4.27  | 1.029              | Very high     |
| 20   | 11  | Learning efficiency                                       | 4.21  | 0.561              | Very high     |
|      |     | The second axis: the effects of the IoT on the ULE         | 4.52  | 0.396              | Very high     |

From Table 7, the second axis’s mean was 4.52, indicating a very high response on the items of the second axis. Standard deviation was 0.396, indicating the excellent homogeneity between the responses in the second axis: IoT’s effects on the ULE.

Table 7 also shows that the means of the axis items ranged from 4.71–4.21, where the “research opportunities” item came with the highest means (4.71), and the degree of impact (very high). The “smart e-learning” item came with an average of 4.64, ranking second with a degree of effect (very large). The “learning efficiency” came with the lowest average (4.21) and an effective degree (very high). The results indicate that the rest of the items for this axis came with a (very high) degree of influence.

These results indicate that faculty members and specialists in Saudi universities are convinced of the capabilities of the Internet of Things in the learning environment and the decision-making system and are fully aware of its importance in achieving the desired goals.

These results can be interpreted in light of the results of some related studies such as Karamis et al.’s 2019 study and Abul Nag et al.’s 2020 study, [34,37] which indicated the impact of using new technologies and how to take advantage of the Internet of Things in providing the information and data that the university needs for knowledge management and cybersecurity, and reducing energy consumption via the Internet of Things. As infras-
structure, support includes many applications, such as a smart card, smart classroom, smart utility services, and security and safety data.

4.3. Answer of Question 3

To answer 3rd Q:

The means and standard deviations of the sample responses to the questionnaire were calculated in the third axis—the challenges of integrating the IoT in universities—are shown in Table 8.

Table 8. The means and standard deviations of the items of the questionnaire in the third axis: the challenges of integrating the IoT in universities, in descending order.

| Rank | No. | Items                                                                 | Mean  | Standard Deviation | Degree of Approval |
|------|-----|----------------------------------------------------------------------|-------|--------------------|--------------------|
| 1    | 9   | Managing devices on the IoT needs periodic software updates.         | 4.78  | 0.414              | Great              |
| 2    | 6   | IoT software development, programming of things.                     | 4.71  | 0.455              | Great              |
| 3    | 1   | The IoT requires new technology and fully advanced analytical equipment for analytics, connectivity, and information integration. | 4.70  | 0.454              | Great              |
| 4    | 13  | The need to shift from models that push knowledge to models of knowledge withdrawal. | 4.64  | 0.480              | Great              |
| 5    | 4   | Data security and data privacy.                                      | 4.51  | 1.109              | Great              |
| 6    | 2   | The complete setup of an IoT-based educational institution can be costly. | 4.49  | 0.830              | Great              |
| 7    | 7   | The processors and architecture of the IoT require the design of tools with knowledge and this requires “deep technical competencies”. | 4.43  | 0.827              | Great              |
| 8    | 14  | The complexity of IoT systems.                                       | 4.07  | 1.105              | Medium             |
| 9    | 15  | Some devices and applications are incompatible and can hinder an organization’s ability to create an IoT setup that is reliable and accessible to everyone. | 4.07  | 0.889              | Medium             |
| 10   | 3   | Some IoT software generates huge amounts of data that need to be analyzed at the same time. | 4.00  | 1.307              | Medium             |
| 11   | 5   | Acquisition, transfer, and management of IoT realities.              | 3.93  | 1.438              | Medium             |
| 12   | 17  | Platforms: the middleware that is used to connect all entities to the IoT. | 3.86  | 1.301              | Medium             |
| 13   | 11  | Weakness of trained personnel to manage the Internet of Things.      | 3.80  | 1.372              | Medium             |
| 14   | 12  | Learning behavior and the culture of learning are pervasive in universities. | 3.79  | 1.317              | Medium             |
| 15   | 8   | Traditional mobile networks do not offer a combination of technical features and operational fees for Internet applications. | 3.72  | 1.334              | Medium             |
| 16   | 16  | There is no unified and codified international standard to achieve interoperability between tags that are installed on entities and objects. | 2.87  | 1.812              | Weak               |
| 17   | 10  | Faculty members fear the integration of the IoT in universities.     | 2.79  | 1.265              | Weak               |

The third axis: the challenges of integrating the IoT in universities

The results of Table 8 indicated that the general mean of the responses of the third axis (4.07) indicates that there is an agreement (medium degree) on the questionnaire items in the third axis. The standard deviation value of the axis (0.592) is an indication of the great homogeneity between the responses of the sample with the questionnaire in the axis of challenges integrating the IoT into universities.

The averages of the axis items ranged from 4.78–2.79, where “the management of devices on the IoT needs periodic software updates”, with the highest average of 4.78, and the degree of approval (large extent). In second place came “IoT software development and programming of things”, with an average of 4.71, and approval (a large degree), whereas “the fear of faculty members about integrating the IoT in universities” came with the lowest average (2.79), and a degree of approval (with a weak degree). The results also indicate that the rest of the items for this axis agreed (large degree to weak degree).

The previous results indicate that there is agreement among the study sample that there are many challenges facing the use of the IoT in universities, foremost of which
is the difficulty of managing devices and developing software because it needs periodic updates to programs. Data security and privacy and the need to shift from models that push knowledge to models of knowledge extraction are among the biggest challenges and the weakness of cadres trained in managing the Internet of Things.

According to previous studies, the preparation of an IoT-based educational institution is expensive, and the processors and architecture of the IoT require complex design and tools that could prove challenging to faculty members.

4.4. Answer of Question 4

To answer 4th Q:
First: comparison by gender—the t-test was used to compare the responses of the sample according to gender, as in Table 9.

Table 9. Results of the T-test to compare the mean responses of the sample to the questionnaire according to gender.

| Axes     | Gender | No. | Means | Std. Deviation | T-Value | Significance |
|----------|--------|-----|-------|----------------|---------|--------------|
| First axis | M      | 190 | 2.39  | 0.683          | 0.208   | 0.836        |
|          | F      | 85  | 2.41  | 0.614          |         |              |
| Second axis | M     | 190 | 4.53  | 0.394          | 0.386   | 0.700        |
|          | F      | 85  | 4.51  | 0.404          |         |              |
| Third axis | M     | 190 | 4.11  | 0.599          | 1.547   | 0.123        |
|          | F      | 85  | 3.99  | 0.569          |         |              |

From Table 9, the T-value was 0.208 and the significance level 0.836, which is a non-statistically significant value for gender in the first axis. Although the value of T was 0.386, and the significance level was 0.700, which is a nonstatistically significant value for gender in the second axis. However, the T-value was 1.547 and the significance level was 0.123, which is a non-statistically significant value for gender in the third axis.

This result is due to the fact that faculty members in Saudi universities, whether male or female, live within the reality of the age of technology and its educational challenges and an academic environment that deals with contemporary technology and its advanced technologies. Supportive of the educational environment in which it is implemented, and renewal using new methods for this technology will improve the work climate in it and develop the services it provides to students, faculty members, staff, and the community, so no differences appeared due to the gender variable.

Second: comparison by scientific rank—the one-way analysis of variance (P) test was used to compare the sample responses as shown in Table 10.

Table 10. Results of the (F) test to compare the mean responses of the sample to the questionnaire according to the scientific rank.

| Axes     | Sources of Variance | Sum of Squares | Degrees of Freedom | Mean of Squares | P-Value | Statistical Significance |
|----------|---------------------|----------------|--------------------|-----------------|---------|------------------------|
| First axis | Between groups     | 0.810          | 4                  | 0.203           |         | 0.766000               |
|          | Within groups      | 119.174        | 270                | 0.441           | 0.4590  |                       |
|          | Total              | 119.984        | 274                |                 |         |                       |
| Second axis | Between groups     | 0.882          | 4                  | 0.221           |         | 0.230                  |
|          | Within groups      | 42.161         | 270                | 0.156           | 1.413   |                       |
|          | Total              | 43.043         | 274                |                 |         |                       |
| Third axis | Between groups     | 1.373          | 4                  | 0.343           |         | 0.4190                 |
|          | Within groups      | 94.495         | 270                | 0.350           | 0.981   |                       |
|          | Total              | 95.867         | 274                | 0.203           |         |                       |

From Table 10, P’s value is 0.459, and the value of statistical significance is 0.766, which is not statistically significant. This indicates that there are no statistically significant
differences in the first axis. For the second axis, $P$ was 1.413 and the value of the statistical significance was 0.230, which is not statistically significant, meaning that there are no statistically significant differences in the sample responses. For the third axis, $P$ was 0.981 and statistical significance was 0.419, which is not statistically significant. This indicates that there are no statistically significant differences.

The research team explains that there are no statistically significant differences between academic ranks, perhaps due to the faculty members’ awareness of the importance of this technology and that it has become inevitably necessary, and the agreement of faculty members with different academic ranks that knowledge management can benefit from the Internet of Things because of its role in supporting decision-making activities and that they contribute to increasing information and expanding its scope, taking into account the challenges and difficulties and ways to confront them. Consequently, the faculty members are fully convinced of the connection between the Internet of Things and knowledge management, regardless of academic rank.

Third: comparison according to the experience—the one-way analysis of variance ($P$) test was used to compare the responses of the sample according to the experience, as shown in Table 11.

Table 11. Results of the (F) test to compare the average responses of the sample to the questionnaire according to the years of experience.

| Axes      | Sources of Variance | Sum of Squares | Degrees of Freedom | Mean of Squares | $P$-Value | Statistical Significance |
|-----------|---------------------|----------------|--------------------|----------------|-----------|--------------------------|
| First axis| Between groups      | 0.246          | 2                  | 0.123          |           | 0.279                   | 0.757 |
|           | Within groups       | 119.738        | 272                | 0.440          |           |                          |      |
|           | Total               | 119.984        | 274                |                | 0.279     | 0.757                   |
|           | Between groups      | 0.012          | 2                  | 0.006          |           | 0.039                   | 0.962 |
|           | Within groups       | 43.031         | 272                | 0.158          |           | 0.039                   |      |
|           | Total               | 43.043         | 274                |                | 0.039     | 0.962                   |
| Second axis| Between groups      | 0.421          | 2                  | 0.211          |           | 0.600                   | 0.549 |
|           | Within groups       | 95.446         | 272                | 0.351          |           | 0.600                   |      |
|           | Total               | 95.867         | 274                |                | 0.600     | 0.549                   |

From Table 11, it was found that $P$ was 0.279 and statistical significance was 0.757, which is not statistically significant. This indicates that there are no statistically significant differences in the sample responses in the first axis. In the second axis, $P$ was 0.039 and statistical significance was 0.962, which is not statistically significant. This indicates that there are no statistically significant differences. In the third axis, $P$ was 0.600, and the statistical significance was 0.549, which is not statistically significant. This indicates no statistically significant differences.

The previous results show the sample responses to a questionnaire about the effects of the Internet of Things on the university learning environment are not affected by any of the variables. This can be explained that the paradigm shift caused by the COVID-19 pandemic.

4.5. Answer of Question 5

To answer 5th Q:

The 12 main criteria and 44 sub-applications were summarized from the analysis of the studies of [2,24,27,38,39] as in Table 12:
Table 12. Proposals for an existing smart IoT-based campus.

| Criteria                      | Applications                                                                 | Reasons                                                                 |
|-------------------------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Smart ID                      | - To attend (classes, laboratories, university facilities).                 | Quick identification of all transactions and a personal database.        |
|                               | - Housing (all residential and administrative activities).                 | It can be accessed through the cloud.                                   |
|                               | - For library transactions (booking, borrowing, recording, printing).       |                                                                         |
|                               | - E-wallet (electronic payments and invoices, financial reservations).     |                                                                         |
|                               | - To record personal data (student information, admission, graduation information, student records, university and volunteer activities, training programs). |                                                                         |
|                               | - Mobile learning, intelligent digital signage, telepresence in classrooms. |                                                                         |
|                               | - Distance learning (online lectures, video conferences, cloud spaces, remote access to information). |                                                                         |
| Smart learning spaces         | - Virtual reality and virtual visits (WebQuest).                           | Enhanced quality of learning, increased interactive, participatory, time-efficient, user-friendly, and sustainable. |
|                               | - Interactive cloud platform (between colleagues and professors, between community and university, government and university). |                                                                         |
|                               | - Participatory research projects (communication with many universities, companies, and research centers). |                                                                         |
|                               | - Adaptive learning (customized learning according to market needs and student interests, personalized learning). | Customize, improve students’ weaknesses, increase class performance, accurate exams, student support, and optional development courses. |
| Adaptive learning             | - Enrichment courses in specialized fields.                               |                                                                         |
|                               | - Computerized Adaptive Test (CAT) (questions tailored to the needs of the laboratory, questions based on previous answers for more accurate results, in-depth assessment). |                                                                         |
| Energy management             | - Energy rationalization and management system (monitoring and automation: lighting, educational equipment, plant operation, air conditioning). | Rationalize resources, reduce costs, achieve sustainability, control, more data to analyze, better planning. |
|                               | - Green energy (solar and wind energy, green buildings)—smart lighting.    |                                                                         |
|                               | - Smart home management system.                                            |                                                                         |
| Security and safety           | - Smart security and safety systems (tracking, monitoring, evacuation)     | Prior prevention, cause analysis, further data analysis.                |
|                               | - Face recognition.                                                        |                                                                         |
| Smart facilities services     | - Cyber security.                                                          | Interactive activities on the campus, full control of the buildings.    |
|                               | - Video surveillance with analysis                                         |                                                                         |
|                               | - Protection and wayfinding.                                               |                                                                         |
|                               | - Sports fields, student centers, entertainment venues, restaurants.       |                                                                         |
|                               | - Special needs services.                                                  |                                                                         |
|                               | - The smart facility management system.                                    |                                                                         |
|                               | - Venue services.                                                          |                                                                         |
|                               | - Facility access control.                                                 |                                                                         |
|                               | - Campus social network (events, live broadcasts, alerts, and information). |                                                                         |
| Criteria | Applications | Reasons |
|----------|--------------|---------|
| **Optimization and analytics data centers** | - Process improvement.<br>- Data storage.<br>- Research center.<br>- Smart parking.<br>- Fleet tracking of all transportation within the university (for Logistics, transportation, smart bus shelters).<br>- Smart signage (navigation, broadcasting).<br>- Campus navigation (smart kiosks, office finding, utilities, events). | Recent improvements, data lakes, unlocking and categorizing data. |
| **Smart transportation** | - Smart parking.<br>- Fleet tracking of all transportation within the university (for Logistics, transportation, smart bus shelters).<br>- Smart signage (navigation, broadcasting).<br>- Campus navigation (smart kiosks, office finding, utilities, events).<br>- Campus operations center. | Improved logistics, news, quick notifications, and better mobility. |
| **Contact management and communication** | - Digital connections.<br>- Campus wi-fi.<br>- Interactive signage and kiosks. | The ability to conduct more informed decision-making by integrating multiple IT devices and applications with the surrounding environment. |
| **Middleware** | - Platforms: a type of “middleware” that connects all entities to the IoT. | Providing access to devices, ensuring installation and commissioning, monitoring of device-operating mechanisms, interoperability, and connectivity on the network or the cloud. |
| **Virtual centers and simulations** | - Guided virtual tours.<br>- Virtual labs.<br>- Virtual museums.<br>- Simulators and simulation software. | Information immersion, collaboration, and sharing, experiencing a variety of semi-real experiences. |
5. Conclusions

Flexibility, high-speed connectivity, accessibility, adaptability, and scalability are characteristics of the IoT. Despite the challenges, the IoT could revolutionize the higher education ecosystem, and bring interconnection—human-to-human, human-to-things, and things-to-things. Higher education and the Internet of Things should be intelligent systems. As a part of the Internet, the IoT is an intelligent network of tools that can create a virtual–digital entity to communicate with the real world and digital world. The IoT is promoting changes in higher education, such as in education and teaching, learning, management, experimenting, and training. Universities could benefit immensely from the IoT and its applications.

With the advancement of IoT uses, universities have overcome many challenges such as tracking key resources, developing access to information, building smarter plans, and designing a safer campus. IoT systems could tremendously motivate students and staff. Data analytics and IoT tools can improve campuses, enhancing information capture, addressing security and privacy issues, reducing energy use, analyzing data, and enhancing learning outcomes.

6. Recommendations and Future Work

The purpose of the study was to discover the potential of the IoT in higher education, to know how to maximize its benefits, and counter its challenges to universities’ integration. Through the results, the study recommends:

- Adopting the proposed vision for integrating the IoT into KM in universities and working on its experiment and development through research teams.
- Keeping up with technical changes and investing in the areas of IoT applications, besides working with smart systems to process knowledge and invest it through smart devices.
- Availing IoT educational applications for trainers and professors to improve research quality.
- For universities to extract tacit knowledge from individuals and competencies and transform it into explicit knowledge, usable in various fields. The IoT may help universities to make appropriate decisions in knowledge investment.
- Conducting field studies to explore aspects of benefiting from the Internet of Things in knowledge management in various fields such as the field of education and learning, the field of human resources, the field of energy, the field of transportation, public utilities, security and safety, and information analysis and processing.

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References

1. Ibrahim, N.I. The revolution of the Internet of digital things and its use in the educational process at Taif University, analytical study, Journal of Educational Technology—Studies and Research. Arab Soc. Educ. Technol. 2018, 37, 309–330.

2. Liu, J.; Wang, C.; Xiao, X. Internet of Things (IoT) Technology for the Development of Intelligent Decision Support Education Platform. Sci. Progr. 2021, 2021, 6482088. [CrossRef]

3. Ibrahim, U.M.; Alamr, A.R. The Effect of Using Cinemagraph Pictures in Social Platforms and Mobile Applications in the Development of Peace Concepts among University of Hail Students. J. Inf. Sci. Eng. 2021, 37, 1341–1361.

4. Al-Dahshan, J.A. Internet of things and its use in education (justifications, areas, challenges). J. Fac. Educ. Arish 2019, 18, 13–55.

5. Gul, S.; Asif, M.; Ahmad, S.; Yasir, M.; Majid, M.; Malik, M.S.A.; Arshad, S. A survey on role of internet of things in education. Int. J. Comput. Sci. Netw. Secur. 2017, 17, 159–165.

6. Ahmed, F. Investing Internet technologies to enhance information awareness mechanisms in information institutions: A planning study. In Proceedings of the 27th conference of the Arab Federation for Libraries and Information (Know-Information Culture in the Arab Knowledge Society: Reality Challenges and Future Bets), Luxor, Egypt, 14–16 November 2016; pp. 1–23.

7. Al-Salmi, J.M.; Abdullah, K.A.; Al-Hinai, A.S. The Role of the Internet of Things in Knowledge Management in Information Institutions, QScience; Hamad Bin Khalifa University Press: Doha, Qatar, 2020.

8. Hassan, H.A. Knowledge Management Strategies in Business Organizations, 1st ed.; Ithra for Publishing and Distribution: Amman, Jordan, 2008.

9. Trees, L. How Technology Will Affect the Future of Knowledge Management. APQC. 2015. Available online: https://www.apqc.org/blog/how-technology-will-affect-future-knowledge-management (accessed on 21 October 2018).

10. Rot, A.; Sobinska, M. The potential of the Internet of Things in knowledge management system. In FedCSIS Position Papers; ACSIS: Pulau Pinang, Malaysia, 2018; pp. 63–68.

11. Al-Akabi, A.T. Internet of Things Applications in Information Institutions, I know magazine. Arab Fed. Libr. Inf. 2017, 19, 161–180.

12. Al-Jabri, S.; Al-Alawi, I. Internet of things and its applications in smart libraries. In Proceedings of the 25th Annual Conference of the Special Libraries Association, Arabian Gulf Chapter: The Internet of Things: The Future of Interconnected Internet Communities, Abu Dhabi, United Arab Emirates, 5–7 March 2019; pp. 520–531.

13. Hoy, M.B. The “Internet of Things”: What it is and what it means for libraries. Med. Ref. Serv. Quatr. 2015, 34, 353–358. [CrossRef] [PubMed]

14. Al-Farsi, A. The Internet of Things: Readiness and Possibility of Its Application in the Main Library of Sultan Qaboos University. In Proceedings of the 25th Annual Conference of the Special Libraries Association, Arabian Gulf Chapter: The Internet of Things: The Future of Interconnected Internet Communities, Abu Dhabi, United Arab Emirates, 5–7 March 2019; pp. 252–282.

15. Qin, J. The Research of the Library Services Based on Internet of Things. In 4th International Symposium on Social Science; Atlantis Press: Amsterdam, The Netherlands, 2018.

16. Abdullah, A. The Internet of Things in Libraries and Information Institutions: Opportunities and Challenges. In Proceedings of the 25th Annual Conference of the Special Libraries Association, Arabian Gulf Chapter: The Internet of Things: The Future of Interconnected Internet Communities, Abu Dhabi, United Arab Emirates, 5–7 March 2019; pp. 6–19.

17. Kahlert, M. Understanding Customer Acceptance of Internet of Things Services in Retailing: An Empirical Study About the Moderating Effect of Degree of Technological Autonomy and Shopping Motivations. Master’s Thesis, University of Twente, Enschede, The Netherlands, 2016.

18. Suduc, A.M.; Bizo, M.; Gorgiu, G. A Survey on IoT in Education. Rom. J. Multidimens. Educ. 2018, 10, 103. [CrossRef]

19. Advances in Mobile Cloud Computing and Big Data in the 5G Era; Mavromoustakis, C.X.; Mastorakis, G.; Dobre, C. (Eds.) Springer International Publishing: Cham, Switzerland, 2017.

20. Ahmed, V.; Alnaaj, K.A.; Saboor, S. An investigation into stakeholders’ perception of smart campus criteria: The American university of Sharjah as a case study. Sustainability 2020, 12, 5187. [CrossRef]

21. Chen, F.; Deng, P.; Wan, J.; Zhang, D.; Vasilakos, A.V.; Rong, X. Data mining for the internet of things: Literature review and challenges. Int. J. Distrib. Sens. Netw. 2018, 11, 431047. [CrossRef]

22. Zhu, Y.; Liang, P. Research on key technologies of data processing in internet of things. In Journal of Physics: Conference Series; IOP Publishing: Bristol, UK, 2017; Volume 887, p. 012047.

23. Mohanty, D. Smart learning using IoT. Int. Res. J. Eng. Tech. 2019, 6, 1032–1037.

24. Abbasy, M.B.; Corrales-Ureña, M.A.; León-Brenes, R.; Loaiza-Berrocal, M. How IoT (Internet of Things) Can Shape Education. In Memorias del I Congreso Internacional de Ciencias Exactas y Naturales de la Universidad Nacional, Costa Rica, En Y. Morales-López ed.; Universidad Nacional: Heredia, Costa Rica, 2019; pp. 1–11. ISBN 978-9968-9661-6-0.

25. Aldowah, H.; Rehman, S.U.; Ghazal, S.; Umar, I.N. Internet of Things in higher education: A study on future learning. J. Phys. Conf. Ser. 2017, 892, 12–17. [CrossRef]

26. Abbasy, M.B.; Quesada, E.V. Predictable influence of IoT (Internet of Things) in the higher education. Int. J. Inf. Educ. Technol. 2017, 7, 914–920. [CrossRef]

27. Ibrahim, U.M.; Alamro, A.R. Effects of Infographics on Developing Computer Knowledge, Skills and Achievement Motivation among Hail University Students. Int. J. Instr. 2021, 14, 907–926. [CrossRef]
28. Mostfa, A.A.; Abdulahad, F.N.; Sharkawy, A.N. AndroidTrack: An Investigation of Using Social Networks’ Applications in Android Platforms. *Iraqi J. Sci.* 2021, 62, 2445–2453. [CrossRef]

29. Al-Emran, M.; Malik, S.I.; Al-Kabi, M.N. A survey of Internet of Things (IoT) in education: Opportunities and challenges. In *Toward Social Internet of Things (SIoT): Enabling Technologies, Architectures and Applications*; Springer: Cham, Switzerland, 2020; pp. 197–209.

30. Agarwal, S.; Pati, S. Study of Internet of Things. *Int. J. Sci. Res. Dev.* 2016, 4, 4.

31. Shin, S.A.; Choi, J.S.; Kim, Y.J.; Lee, N.Y.; Park, J.H. Empirical Study on IoT-Learning for the Rehabilitation Treatment of Chronic Low Back Pain Patients. In *Advances in Computer Science and Ubiquitous Computing*; Springer: Singapore, 2016; pp. 517–524.

32. Al-Kubaisi, S. *Knowledge Management, Cairo: Arab Administrative Development Organization*; League of Arab States: Cairo, Egypt, 2011.

33. Abd, B.T. The Internet of Things The Future of Internet Connected Societies Knowledge Management: Smart Libraries. In Proceedings of the Working Papers of the 25th Annual Conference of the Specialized Libraries Association, Arabian Gulf Chapter: The Internet of Things: The Future of Interconnected Internet Communities, Abu Dhabi, United Arab Emirates, 5–7 March 2019; pp. 290–298.

34. Creswell, J. *Research Design Qualitative, Quantitative, and Mix Methods Approaches*, 3rd ed.; SAGE Publication, Inc.: Newbury Park, CA, USA, 2009.

35. Hoq, K.M.G.; Akter, R. Knowledge management in universities: Role of knowledge workers. *Bangladesh J. Libr. Inf. Sci.* 2012, 2, 92–102. [CrossRef]

36. Stedman, N.L.; Adams, B.L. Identifying faculty’s knowledge of critical thinking concepts and perceptions of critical thinking instruction in higher education. *NACTA J.* 2012, 56, 9–14.

37. Kiryakova, G.; Yordanova, L.; Angelova, N. Can we make Schools and Universities smarter with the Internet of Things? *TEM J.* 2017, 6, 80–84.

38. Abualnaaj, K.; Ahmed, V.; Saboor, S. A Strategic Framework for Smart Campus. In Proceedings of the International Conference on Industrial Engineering and Operations Management, Dubai, United Arab Emirates, 10–12 March 2020; pp. 34–66.

39. Sandy, D.; Gary, K.; Sohoni, S. Impact of a virtualized IoT environment on online students. In *2020 IEEE Frontiers in Education Conference (FIE)*; IEEE: Manhattan, NY, USA, 2020; pp. 1–5.