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Using Relational Database to Effectively Manage and Monitor Institutional Research Activities

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Using Relational Database to Effectively Manage and Monitor Institutional Research Activities

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***Abstract*- One of the widely used database management systems is based on Relational Databases (RL). Although there are other systems to manage data, such as graph database, hierarchical databased, etc., RL has become popular due to its simplicity and intuitiveness. However, RL has challenges to model some data dependencies such as the well known Many-to-Many (M:M) relationships. This paper demonstrates the use of RL databases to effectively manage and monitor research activities in higher educational institutions. This management simplifies the generation of reports, time trends, and event tables. A comparison between RL and other database management systems is also presented showing advantages of the use of RL in this field, thus it is evident that such research is disseminated to interested universities in the nation and abroad.**

***Keywords*- Higher education research management, Technology in education, Microsoft Access Data base management system.**

I. INTRODUCTION

The database management systems DBMS are very essential in our world today, especially that decisions based on data, are more powerful, and more successful. There are many platforms to facilitate DBMS, such as Oracle Database, mySQL, IBM db2, Microsoft SQL, Microsoft Access, SQLite, etc. It's a designer choice to select the platform of choice. Some of the reasons of such selection can be available firm licensing, ease of use, prior training and or experiences.

The objective of transferring data to ordered data into a DBMS is not only to provide electronic data storage, but most importantly, to process such data. Data processing can be based on search queries, (that's why Structured Query Language SQL is very important), reporting, analysis, predictions, monitoring graphs, and so on.

In this paper we first compare between different architectures of databases in Section 2, then in Section 3, we show how the dilemma of Many to Many (M:M) relationship can be resolved in Relational Databases. In Section 4 we show a step-by-step illustration on how we selected the relational database management system and Microsoft Access to design an effective software tool to manage and monitor higher institution's research publications and scientific activities. In Section 5, the paper concludes and we present suggestions of future work.

II. COMPARISON BETWEEN RELATIONAL DATABASE AND ALTERNATIVE DATABASE TECHNIQUES

Conventual ways to manage data include:

- Graphical Database
- Hierarchical Database
- Relational Databases

Graphical databases are based on a labeled-property graph data model consist of four components:

- Nodes - the main entities in a graph.
- Relationships - the connections between the nodes.
- Labels - attributes that group similar nodes together.
- Properties - key/value pairs that are stored within nodes.

Graph databases use Cypher Query Language to query, manage and manipulate data [1, 2, 3]. Even though it is more efficient than RL in handling complex relations, it is not widely used such as in RL databases due to their complexity.

Hierarchical databases HDB are also known as navigational databases. HDB are a means of organizing data with one-to-many pointers. Parent structures (e.g., tables) can have many "children," but each child can only have one parent pointer. Adding and deleting new data is easy in this system; compared to RL. Furthermore, HDB does not support many-to-many relationships. Because of these disadvantages, it is not widely used.

Relational databases RL store data in tables consisting of rows and columns. Every row is a record, and every column is field of that record. Relational databases are usually composed of set of tables. Multiple tables can be linked to each other using keys. Primary keys are unique to each row in a table, (such as researcher ID), while other keys are used to link rows in one table to rows in another table. Relational databases use Structured Query Language (SQL) to query, manage and manipulate data. One of the main advantages of Relational databases is their wide use in various in applications such as in agriculture, medical, academic, banking, and inventory management systems [4-23].

III. HOW CAN MANY TO MANY RELATIONS BE MODELED IN RELATIONAL DATABASES

As mentioned earlier, Relational databases (RL) store data in tables consisting of rows and columns. Every row is a

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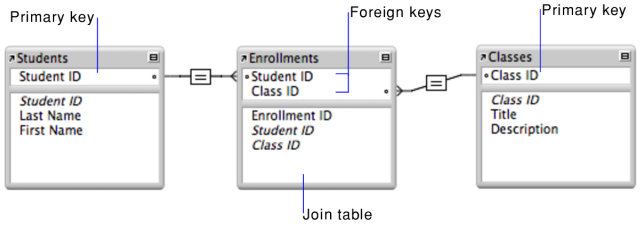

Figure 1: Example of M:M relationship

record, and every column is field. Examples include table of students, where each student must have a unique student ID. Similarly, classes that can be taken each has a class ID, along with course title, description, and so on. Evidently, many students can take a particular class, and a class can be taken by many students. To represent such a complex relationship, we create another table, as shown in Figure 1, were a single value of the primary key from the student table, is joined with a single value of a primary key of the classes table. In this join table, student ID can be repeated (since a student my desire to have more than one class), and course ID can be repeated (since a class is taken by many students). But the pair of Student ID and Class ID should not be repeated. This is how a M:M relationship is represented easily in RL databases.

IV. USING MICROSOFT ACCESS TO DESIGN EFFECTIVE SOFTWARE TOOL TO MANAGE AND MONITOR HIGHER INSTITUTION'S RESEARCH PUBLICATIONS AND SCIENTIFIC ACTIVITIES

We first create tables for faculty and staff, then we use Microsoft Access forms to allow ordered data entry in such

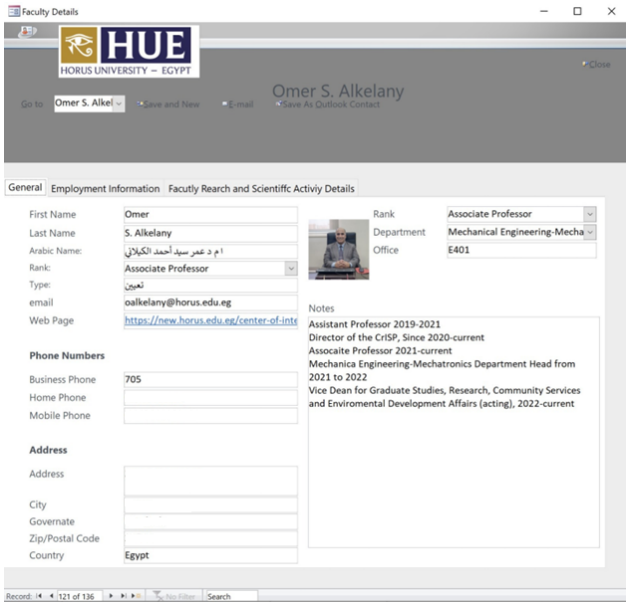

Figure 2: Example Form for Faculty and Staff data entry (some of the data are removed here to maintain privacy)

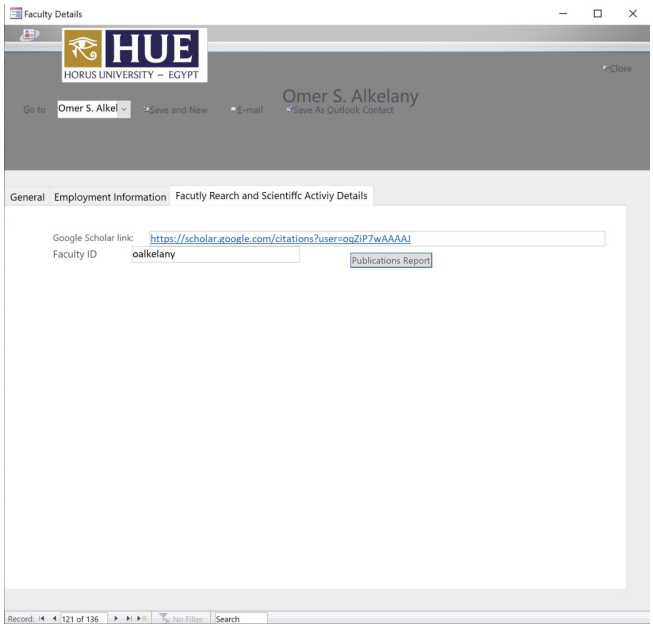

Figure 3: Using the same form for the same Faculty member to enter more data (showing research specific data entry tab)

table. Figure 2 shows an example form to enter faculty and staff data. Multiple data records are entered, and shown in the figure the record of the author (no. 121 of total 136), who are affiliated with Horus University- Egypt, faculty of Engineering. We used multiple tabs to enter more specific data about faculty members. Figure 3 shows how some further (research specific) data was entered. Notice how the primary key was specified so that this record can be joined with the faculty member research work, and scientific events. An easy choice for the faculty ID is the email ID, which is unique over the domain of the whole institution.

A similar form was used to enter research publications for each faculty member (using replications of the Faculty ID(s), who were authors of the same publication). As shown in Figure 4, each publication has a unique Publication ID. Joining these two keys, automatically ensures that there are no duplicates of research publications listing in the same institution. Each publication can be given a code to specify its type, and for quicker data entry, we created these codes:

C: Conference paper
J: Journal paper
Pt: Patent
BC: Book chapter
B: Book
M: Master thesis
P: PhD dissertation

Figure 5 shows an example report showing one article per row, and list of authors (internal, or external), as well as the type of each publication (C/J/BC/B/M/P/Pt). Using codes reduces typing errors. Of course, more codes can be added as desired. Joining two tables to create such report is very useful in the next steps when we report trends, and helps in getting

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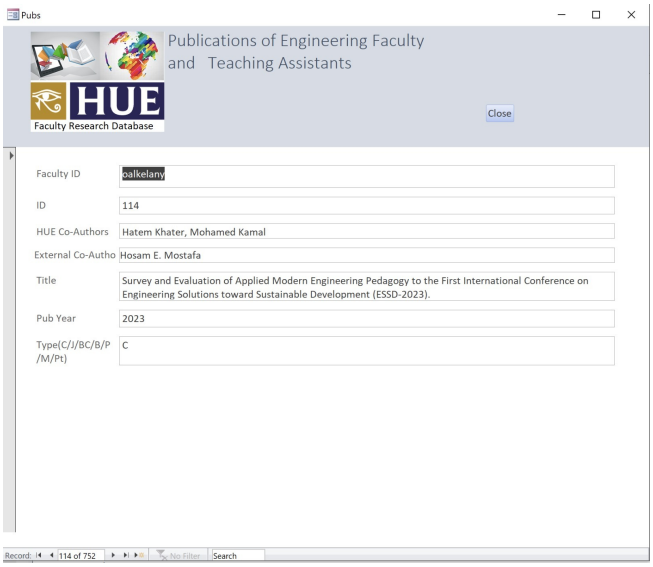

Figure 4: Publication data entry form

more accurate predictions of the faculty performance as desired. One of the nice features in the platform we chose is the ability to create graphs, and calculate trends. Figure 6 shows a computed trend: Publications/Authors over the years.

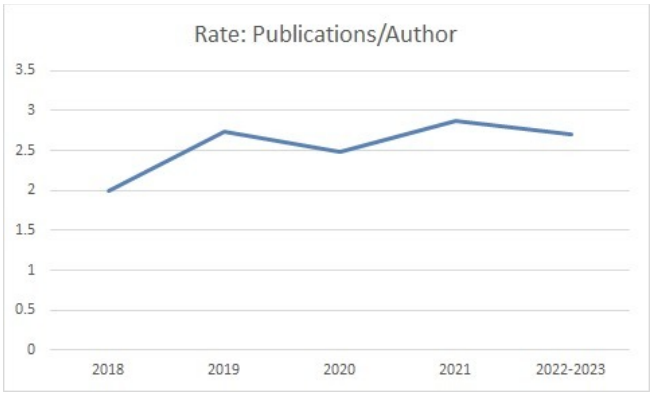

Figure 6: Automatically computed graph showing the trend of Publications/Authors over the years for the institution

Similarly, we designed forms to monitor and manage scientific activities. In the data entry phase of each scientific even, group of coordinators can be assigned. This is also a M:M relationship. Thus, another join operation was used. Figure 7 shows the data entry form for events, and the tab for assigning coordinators. The data entry personnel will only need to navigate (possibly by entering the first letter of the desired name using the keyboard), select from list and the name will be stored. Shown in the figure multiple choices for a single event. Notice how can attachments for relevant documents can be inserted in the form. This helps in easy navigation of relevant documents, and even for the presentation of proofs for accreditation authorities.

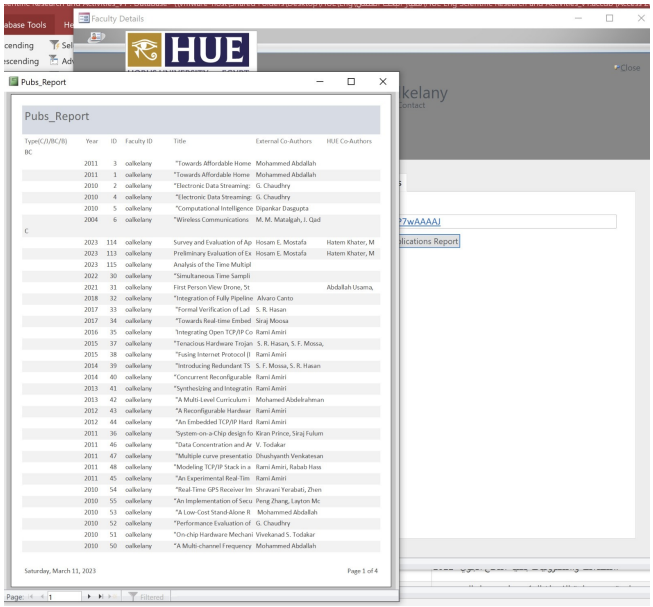

Figure 5: Publication Report showing ordered list, and abbreviation of publication types, participating authors, and year of publication

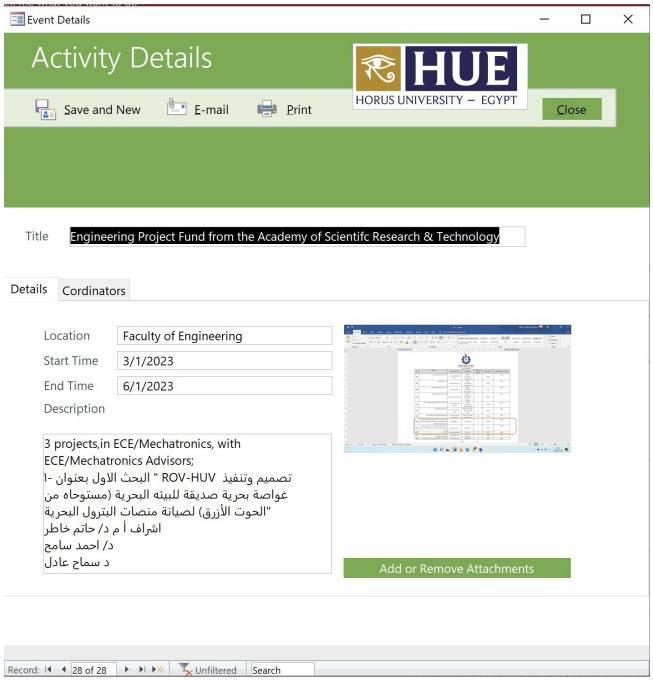

Figure 7: Event form, and the attachments window (pictures, pdf files can be added and stored in the database)

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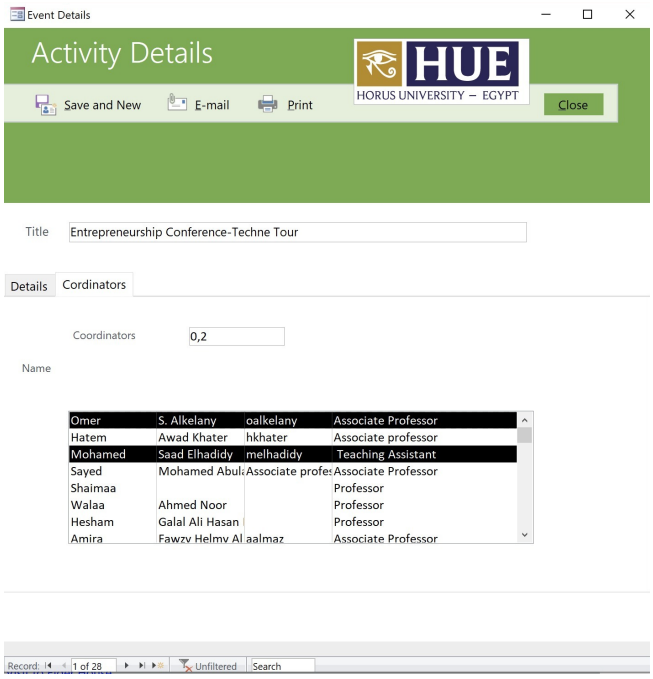

Figure 8: Event form, and the coordinator assignment tab (for a different scientific event)

V. CONCLUSIONS AND FUTURE WORK

In this paper, the we presented a design of a relational database management system for higher educational scientific research activities. Detailed step by step illustrations were give, so that other institutions can use it to duplicate the experiences and benefit from them. Furthermore, we compared various database management systems, showing that relational database, even in complex form is easier to manage, and useful to apply.

In the future, we plan to add more queries and prediction functions to facilitate the management of such important reservoir. We also plan to evaluate the migration of data to a NoSQL platform such as the research cited in [10, 11]. Some of the desired functions is to extrapolate research publications (of the recent past) and predict research outcome in the upcoming years. This can be very useful to evaluate the performance of research faculty, especially in the endeavor of achieving accreditation by agencies such as the National Authority for Quality Assurance and Accreditation of Education NAQAE in Egypt [24], and the International Accreditation Board for Engineering and Technology (ABET). Needless to say, ABET is ISO 9001:2015 certified [25].

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Conflicts of Interest:
The author declares that he has no conflict of interest regarding this research paper and that he complies with research ethics.

REFERENCES

[1] Nan, Zhihong • Bai, Xue, *The study on data migration from relational database to graph database*- 12019/11/, Journal of Physics: Conference Series 1345 (2), 022061, 2019.
[2] Sun, Shanxin • Meng, Fanchao • Chu, Dianhui, *A Model Driven Approach to Constructing Knowledge Graph from Relational Database* , 12020/7/, Journal of Physics: Conference Series 1584 (1), 012073, 2020.
[3] Mahmoud Elsabagh, *NO SQL Database: Graph database*, Kafrelsheikh University, Faculty of Artificial Intelligence, 2022.
[4] Scoville, N. Z. , Carlstrom, J. E., Chandler, C. J. , Phillips, J. A. , Scott, S. L., Tilanus, R. P. J., Wang, Z , *The Relational Database And Calibration Software For The Caltech Millimeter Array*, Publications of the Astronomical Society of the Pacific 105 (694), 1482-1494, 1993.
[5] J Cranshaw, L Goosens, D Malon, H McGlone, F T A Viegas, *Building a scalable event-level metadata service for ATLAS*, IOP Journals, 119 072012,(7), 2008
[6] Sucipto, S, Resti, N C, Andriyanto, T, Karaman, J, Qamaria, R S, *Transactional database design information system web-based tracer study integrated telegram bot*, 12019/11/, Journal of Physics: Conference Series 1381 (1), 012008, 2019.
[7] Imamuddin, A, Nahar, I, Chandra, S, TransJoin: *An Algorithm to Implement Division Operator of Relational Algebra in Structured Query Language*, 12020/3/, Journal of Physics: Conference Series 1477 (3), 032003, 2020.
[8] Sug, Hyontai, *Efficient checking of functional dependencies for relations*, 12020/6/, Journal of Physics: Conference Series 1564 (1), 012011, 2011.
[9] Akbar, Mohammad Deni, Mizoguchi, Yoshihiro, Adiwijaya, *Class dependency of fuzzy relational database using relational calculus and conditional probability*, 12018/3/, Journal of Physics: Conference Series 971 (1), 012001, 2001.
[10] Ghotiya, Sunita, Mandal, Juhi, Kandasamy, Saravanakumar, *Migration from relational to NoSQL database*, 12017/11/, Conference Series: Materials Science and Engineering 263 (4), 042055, 2017.
[11] Erraji, Abdelhak, Maizate, Abderrahim, Ouzzif, Mohamed Ibn Batouta, Zouhair, *Migrating Data Semantic from Relational Database System To NOSQL Systems to Improve Data Quality for Big Data Analytics System*, Electrochemical Society Transactions, 107(1), p19495-19503, 2022.
[12] Abdulrahman Aldawood; Ibrahim Alshahwan, Abdullah Al-Sadon,, Abdulrahman Al-Azba, Omar Abdalla, Alshamy Adam,; Ali Almasrahy, *Designing An Integrated Computer Program For Vegetable Insect, Non Insect Pests And Diseases Affecting Vegetable Crops*, Ain Shams University, 2010.
[13] Fawzia S. Ali, ; Ebtesam A. Yousef; Mahmoud H. Hegab; Nehad Khalifa, *Morphological re-description and molecular characterization of Heterocypris salina (Brady, 1868), a new recorded ostracod species in Egypt*, 2018.
[14] Kamh Mahmoud, *Impact of Agricultural Practices on Soil Productivity and Sustainability of Abis Experimental Research Station (AbisERS)*, Egypt, 2016.
[15] Andhika Naafi Ramadhan, Kharisma Naufal Pane, Suharjito, *Blockchain and API Development to Improve Relational Database Integrity and System Interoperability*, 102023/1/, 2023.
[16] Patricia Córdoba-Hidalgo; Nicolás Marín; Daniel Sánchez; *RL-instances: An alternative to conjunctive fuzzy sets of tuples for flexible querying in relational databases*, 42022/4/, Fuzzy Sets and Systems, 445, pp. 184-206, 2022.
[17] Bo Zhang; Shaofeng Liu; Chenxi Zhang; *EaDz: A web-based, relational database for detrital zircons from East Asia*, 212022/12/, : Computers & Geosciences, 171, p. 105288, 2022.
[18] Batool Lakzaei; Mehrnoush Shamsfard: *Ontology learning from relational databases*, 292021/6/, Information Sciences, 577, pp. 280-297, 2021.
[19] Yoonmi Shin; Jinhyun Ahn; Dong-Hyuk Im, *Join optimization for inverted index technique on relational database management systems*, 232022/3/, Expert Systems with Applications, 198, p. 116956, 2022.
[20] T. H. Cao: *A relational database model and algebra integrating fuzzy attributes and probabilistic tuples,* 92021/11/, Fuzzy Sets and Systems, 445, pp. 123-146, 2021.
[21] Dennis Timlin; David Fleisher; Vangimalla Reddy; *CLASSIM: A relational database driven crop model interface*, 292023/6/, Smart Agricultural Technology, 5, p. 100281, 2023.

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©Tanta University, Faculty of Engineering
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[22] Bouchra El Idrissi; Salah Baïna; Mina Elmaallam: *RDF/OWL storage and management in relational database management systems: A comparative study*, 72021/10/, Journal of King Saud University-Computer and Information Sciences, 34(9), pp. 7604-7620, 2021.
[23] Benymol Jose; Sajimon Abraham: *Performance analysis of NoSQL and relational databases with MongoDB and MySQL*, 292020/5/, Materials Today: Proceedings, 24, pp. 2036-2043, 2020.
[24] -, *National Authority for Quality Assurance and Accreditation of Education*, https://naqaae.eg/ar/about_us, Accessed 2023.
[25] -, *Accreditation Board of Engineering and Technology*, https://www.abet.org/accreditation/what-is-accreditation/why-abet-accreditation-matters/iso-90012015/ Accessed 2023.

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