

Design and Implementation of an Industrial Information System for Enhancing Educational Workshop Efficiency: A Case Study at Sultan Qaboos University

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Abstract

Industrial information systems play a pivotal role in enhancing the efficiency of operations in both industrial and service organizations. These systems facilitate the capture of data, execution of business processes, and monitoring of these processes, thereby streamlining operations. A crucial component of these systems is the database system, which allows for efficient storage, updating, and access to data. The integration of robust database systems within industrial information systems highlights their importance in ensuring seamless data management. The educational workshop at the Mechanical and Industrial Engineering Department, the College of Engineering at Sultan Qaboos University (SQU) is an integral part of both undergraduate and postgraduate courses. It also provides substantial support for final year and research projects. However, the efficient management of information related to research devices, components used in these projects, and equipment usage presented a challenge. Recognizing this need, and as part of the Industrial Information System course project, we were motivated to develop a comprehensive database system. This system is designed not only to streamline information management but also to enhance the overall efficiency and effectiveness of the workshop and its related resources. The specific objectives of this course project are threefold. Firstly, we aim to develop a high-level data model that accurately represents the data requirements of the workshop. The second objective is to create a relational data model that effectively organizes the data into a set of linked tables. Lastly, we aim to develop and rigorously test the workshop database to ensure its robustness and reliability.

These objectives provide a clear and focused direction for the successful completion of the project, ensuring that the database system will effectively meet the needs of the workshop. The methodology followed to achieve the objectives of this project was systematic and thorough. It begins with gathering and analyzing data requirements, involving visits to the workshop, and conducting interviews with staff members to understand their needs. The next phase includes constructing an Entity-Relationship (E-R) Diagram using Dia software, providing a visual representation of the data requirements. This E-R diagram is then reviewed with workshop representatives to ensure the suitability of the database design for their requirements. Once approved, the E-R model is mapped into a relational data model, forming the basis of the database's logical design. To ensure data integrity and reduce redundancy, the database design is then normalized. Following this, the relational data model is implemented in LibreOffice Base, a free and open-source database management system that can create databases and link between one another by function as a user interface thus offering a practical and user-friendly platform for data management. The final phase involves rigorous testing of the database, including data insertion and functionality checks to ensure its robustness and reliability.

This project has successfully resulted in a preliminary database that efficiently meets the needs of the educational workshop. Through careful analysis and understanding of data requirements, we detailed the number and types of entities, their respective attributes and types, and the relationships between entities. An E-R diagram was constructed, graphically representing these elements. It comprises 13 entities and 32 relationships of unary, binary, and tertiary relationships. This E-R model was then transformed into a relational database model, which comprises a set of tables that are linked together by foreign keys which are primary keys in other tables, establishing new constraints and bounds between data of the related tables. Then implemented in LibreOffice Base. The final product is a

comprehensive database comprising 25 tables, and 25 queries that facilitate the retrieval of specific data from a large number of records to support the work in the college's workshop. Moreover, 25 reports, and 19 user interface forms allow users to manage a large volume of records and facilitate seamless data retrieval, search, modification, and deletion, without requiring in-depth knowledge of the database's underlying complexities.

We are currently working in close collaboration with the workshop administration to conduct comprehensive tests on the completed database. After reviewing the database, the workshop administration requested the inclusion of the location for each component in labs, workshops, and offices. Additionally, they asked for the user of these components to be recorded each time they are utilized. In response to their request, we incorporated these fields into the database, thereby enhancing our ability to provide essential data. Our joint efforts are focused on enhancing its functionality and user interfaces, guided by the invaluable feedback provided by the workshop administration. As a result of these efforts, the objective of creating the workshop's database has been successfully met. However, we believe in continuous improvement and are committed to further enhancing the database. Looking ahead, we are considering opportunities for such improvements. For instance, one potential enhancement could be the integration of the database with online platforms. This would allow remote access to the database, catering to the needs of various interested parties. As we move forward, we remain dedicated to ensuring the database effectively meets the needs of all users.

Keywords

Industrial Engineering, Industrial Information Systems, Database Design, Data Modeling, E-R Model, Relational Data Model, Educational Workshop, Information Management, Efficiency.

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Biographies

Firas Al-Zadjali is affiliated with Sultan Qaboos University. He is an industrial engineering student who cooperated greatly with the team in creating the most efficient industrial information system.

Saud Al-Bulushi is affiliated with Sultan Qaboos University. He is an industrial engineering student that was considered as the backbone of the team due to his expertise towards the project's subject.

Ahmed Al-Abdali Sultan Qaboos University. He is an industrial engineering student who provided great assistance for the team and made sure that the progress plan was followed.

Ahmed Shaban is an Associate Professor in the Mechanical and Industrial Engineering Department at Sultan Qaboos University, where he is involved in research and teaching activities relating to IE & operations research. He received his BSc in Industrial Engineering with honor degree from the Industrial Engineering Department at Fayoum University, Egypt, in 2006. He obtained his MSc in Mechanical Design and Production (IE specialty) from the Mechanical Design and Production Department at Cairo University, in 2010. He received his PhD in Industrial Engineering from the Sapienza University of Rome, Italy, in 2014. His current research interests involve modelling and optimization, simulation, supply chain, healthcare systems and energy systems. He has published numerous research papers in high-quality journals. He is a reviewer for many international journals. He is also appointed as an editorial board member for several journals.

Nasr Al-Hinai is an Associate Professor and the Head of the Mechanical and Industrial Engineering Department at Sultan Qaboos University, Oman. He received his MSc from the Department of Mechanical, Manufacturing, and Aerospace Engineering, UMIST, UK in 2003 and his PhD in Industrial Engineering from the University of Manitoba, Canada, in 2011. He joined SQU in 2001 after completing his BEng. His research interests lie in production planning and control, metaheuristics in operations research, product design and development, project management, and analysis of bio-composites development processes. He has published several research papers in peer-reviewed international journals and conference proceedings.