Advances in UAE Archaeology

Proceedings of Abu Dhabi’s Archaeology Conference 2022
Advances in UAE Archaeology details the results of new excavations conducted across the United Arab Emirates over the last few years. These excavations have revealed a wealth of new data on all periods of UAE archaeology from the Palaeolithic to the recent past. Some of these discoveries have filled in important gaps in our knowledge, while others have fundamentally revised what we thought we knew already. For example, the Marawah Island excavations have added a new facet to our understanding of the Neolithic period by revealing intriguing and hitherto unknown funerary rituals.

Excavations in Al Ain in the emirate of Abu Dhabi continue to reveal extraordinary evidence of falaj irrigation, stretching back 3000 years. The ubiquity of this system across this oasis city further validates its status as a UNESCO World Heritage Site. Of particular importance is the discovery of extensive remains from the Late Pre-Islamic period, a significant time in history that has been best revealed in the excavations at Mleiha in the emirate of Sharjah.

The research presented here was conducted by specialists from across the world working alongside an ever-growing cadre of Emirati archaeologists who will take the lead in the coming years in revealing more of this country’s extraordinary archaeology and history.
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Abstract: The capacity for heritage professionals to effectively manage heritage resources is contingent on access to reliable, up-to-date information. Over the past four years, the Department of Culture and Tourism – Abu Dhabi has developed the Abu Dhabi Historic Environment Record (ADHER). This is bespoke, geospatial software for cultural heritage management. The software features interfaces in Arabic and English, and includes data input wizards, detailed records, resources and reports. Designed with intuitive user interfaces, the software allows for a comprehensive range of search options, while communication protocols (APIs) enable data exchange and filtering with a range of applications used by other departments and external entities. The software has been developed with mobile applications for patrolling conservation areas and change monitoring. While the geospatial data set is an essential baseline for informed decision-making, the software offers important opportunities for a more dynamic interaction with museums, schools, universities and local communities.

Keywords: Big data, historic environment record, cultural heritage management, GIS, software development, data standards

Background
For antiquities departments and heritage authorities around the world, the effective management and protection of cultural resources presents a major challenge. Meeting this challenge requires access to information regarding the importance, location, extent and threats to cultural heritage. As the pace of development increases, there is growing pressure on heritage authorities to provide detailed curatorial and development control advice in advance of planning proposals. While commercial-off-the-shelf geospatial databases assist with understanding the distribution and location of sites, the absence of ‘linked data’ means that often the depth of information is woefully inadequate. A dynamic, geospatial Historic Environment Record (HER) enables informed decision-making at local, regional and national levels, while the wider opportunities offered by a HER include a comprehensive repository of digital and
non-digital heritage resources for researchers, educators and the general public. The need to record heritage is recognised through various international conventions and charters such as the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage (Article 6:3 1972), the ICOMOS Principles for the Recording of Monuments, Groups of Buildings and Sites (1996) and the UNESCO Convention on the Protection of Underwater Cultural Heritage (Articles 2 and 10, 2001).

Another important incentive for developing ADHER was that a significant amount of data had accrued since the early archaeological missions in Abu Dhabi in the 1950s. While data was under the custody of the Department of Culture and Tourism – Abu Dhabi (DCT), it had been generated and stored by different organisations and could not be easily accessed, searched or retrieved. Data was stored in multiple locations and formats (such as hard copy reports and different computer file formats), and the development of ADHER was seen as an ideal opportunity to ensure data was accessible within one platform.

Interface design
When designing a database, what to record and at what level of detail significantly affects the scale and resolution of the data. This issue also impacts data retrieval and the amount of time needed to create and enhance records. It may be tempting to develop interfaces with multiple mandatory fields that require very detailed information for each new record. While the prospect of a comprehensive data set is appealing, the value and quality of data must be worth the user time invested in data entry with particular reference to the value of the data set to end users. This means that when finalising the resolution of data entry (the number and type of mandatory attribute fields) significant consideration should be given regarding which data fields will be searched and retrieved by future business users and how data may be practically applied by the business user to improve our understanding of the historic environment. Furthermore, the desire for a comprehensive dataset should not place a major burden on users and thereby a disincentive for the entry of new data. The number of mandatory fields within ADHER has been kept to a minimum in order to encourage the easy creation of new records and use of the system.

Data Entry Wizards and interface design
The design of a software interface should be appealing but should also support an intuitive workflow. When a user creates a new record, ADHER opens a Data Entry Wizard interface to guide the user logically through data entry. A few important fields are mandatory to complete, while the use of drop-down/pick lists helps constrain data entry to a limited range of terms. Constraining data
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entry is very important, as it prevents users from creating new or duplicate names for existing attributes that might then be missed during a data search. It also helps to improve the quality and standardisation of data.

Wherever possible, interfaces have been developed using standard icons on buttons rather than a word. The same icons are used in both the Arabic and English interfaces and, unlike words, do not require translation. Standard icons include, for example, the schematic depiction of a floppy disk. While a floppy disk is old technology, everyone using a computer recognises this as the icon for ‘Save’. Similarly, the schematic image of a printer is the button for ‘Print’. The developers provided the initial interface design proposals (Figure 1), which included a Data Search results and timeline window. However, it was clear that the Map View window needed to be a comparatively large window within the interface as the visual representation of the map and map features were important to the user experience. The ADHER project team held a series of meetings with DCT software designers discussing the purpose of the software, the user experience and business workflow. The software design team returned with several iterations of the interface before the design of the main interface was finalised.

Figure 1: Early design concept for the ADHER main user interface. This includes a Data Search Results window within the left-hand side of the interface and a timeline search across the top of the interface.
Data standards

The ADHER project commenced in 2018 with a situation assessment report and audit of existing data. This highlighted the type and extent of data held by the DCT and identified existing data standards that should be included within ADHER. For example, the Historic Environment Department has for many years ascribed each Heritage Asset with a unique identifier or site code. This nomenclature of site codes follows a system of three letters and four numbers. The first three letters are determined by the area name of the site (for example, sites at Hili will have a three letter HIL prefix), and the following four numbers are allocated sequentially, providing a unique number for each Heritage Asset. These site codes were used over many years on recording forms (context, survey pro forma, etc.) reports, artefacts, finds bags etc. Creating a new data standard and allocating new codes to legacy archives would have involved renumbering the site codes on a vast number of archives and was therefore considered impractical. An alternative was to record previous site codes as a separate attribute field, and while this option was included in ADHER, the existing nomenclature and data standard (three letters and four numbers) was retained as the unique identifier for heritage assets.

Site codes and unique identifiers

As pre-existing site codes were based on site names, the ADHER team used spatial analysis to ensure a unique site code (based on legacy codes) could be provided for all sites within the terrestrial and marine areas in Abu Dhabi as a unique reference for each site (three letters and four numbers, Figure 2). Each area has a different alpha code (the first three letters), totalling 240 across the emirate. The characters of each site code are based on the location and the number and are provided from three sources. The first source relates to the first three letters and uses existing site codes, all of which remain the same as the initials of the legacy codes for each area. The second source also relates to the first three letters and is from new areas where no previous legacy heritage data was available. The site code assigned to these areas is based on the municipality name or old names used in the past. Data relating to the first three letters of the site code are contained within a GIS geospatial layer (the DCT areas). When a new site is added to ADHER, the third source, the next available number, is automatically generated. Since location is a mandatory attribute, the user must select a location for the site, which generates the first three letters based on the site code assigned to the location within the geospatial layer and provides the next available number within that location. This avoids any duplication as the system will not accept more than one site with the same site code.

While legacy data is being entered, it will be possible to change the allocated site code. This is because there needs to be the flexibility to change the
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Site code to align with site codes that have already been used. However, once all the legacy data has been entered, the plan is to lock the Site Code field. This means that ADHER will provide the business user with the site code (or unique identifier) as each new record is created.

System development

Two popular methods for developing bespoke software are ‘waterfall development’ and ‘agile or sprint development’. Waterfall development is linear and broken into separate phases, whereby each phase is completed before commencing work on the next phase. Usually this is accompanied by detailed design documentation that is agreed prior to the commencement of works. A waterfall development has the advantage of having a predefined, clear structure, with approved design standards that can be referenced throughout the development. However, with this approach there is less flexibility to change the direction of the design or functionality of the development once work has commenced.

An agile or sprint development involves iterative cycles in which multiple development phases run concurrently. During each phase, the business user tests and feeds back to the programmer, allowing some flexibility for the direction of the software to be changed before proceeding to the following stage. Agile developments generally begin with a high-level scoping document for application design, with much of the detailed design undertaken.
as the development progresses. The design is then reviewed and updated as the cyclic process of development, testing and refining of each ‘sprint’ is completed.

For the development of ADHER, an agile approach with a total of eight sprints was adopted. Each sprint was 1 to 1.2 months in development. This approach offered greater flexibility, but the lack of detailed design documentation became an issue as there was no clear agreement on the functionality of interfaces and no data standard for the colour scheme and interface design. This was to some extent resolved by insisting a design document was produced and agreed prior to the start of each sprint. Any thesauri to be included in the attribute fields were added to an Excel spreadsheet, which was also translated into Arabic for the Arabic interface. At this point the data standards and data resolution were finalised. This detailed the mandatory attribute fields required for a basic record and the number of non-mandatory data fields. The number of mandatory fields was reduced to an absolute minimum so as not to be a deterrent to system users. All mandatory attribute fields were included in the data entry wizard to assist the user when a new record is created and ensure standardised data entry between users. Following the completion of the Data Entry Wizard, the user may open the new record and enhance the data with associated attribute fields not previously available in the Data Entry Wizard.

**Data standards**

A Historic Environment Record is much more than simply a geospatial register of heritage assets, since it links map features with multiple attribute fields and data sources, broadly termed ‘Events’ and ‘Resources’. Events include any activity relating to how and who gathered heritage information (field surveys, geophysical surveys, excavations, marine diving inspections, building recording, organisations, people, and so on). This is important as it helps to understand the reliability of, and biases within, the data. Normally an ‘event’ is recorded as a polygon, but it may also be recorded as points or lines. A single event may be linked to multiple sites (for example, where field survey records multiple sites) and one site may be linked to any number of events. This is important where multiple projects have been undertaken on one site. Events may also be linked to each other.

‘Resources’ include all published and unpublished documentation relevant to a Heritage Asset or an event, such as old excavation reports, grey literature and journal articles. This also includes old photographs, aerial photographs, maps and plans, site archives and information about people and organisations involved in the collection and analysis of heritage data. Most importantly, these different kinds of data can be linked or referenced together so that a keyword search of the database will retrieve all related data irrespective of the
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data source. ADHER was therefore designed to address the issues of multiple file formats and storage by providing a central repository that could form a ‘single point of truth’ for heritage data in Abu Dhabi.

**System architecture**

ADHER is a bespoke software based on ArcGIS Java Script 3 with multi-tier architecture comprising Web, application and data services tiers. The Web tier includes the Web adapters for the portal and ArcGIS servers, which are accessed by the user through a Web browser as the system’s entry point. The application tier contains the back-end components of Esri and Microsoft, which provide the geospatial capabilities and expose them through Web services. Data is stored in the form of tables within a Relational Database Management System (RDBMS) database that is based on Microsoft Structured Query Language (SQL) Server Enterprise Edition. The RBMS contains the schemas, which store information such as heritage assets, events, areas, metadata and attribute information, and provides a dependable method of storing and retrieving large amounts of data without compromising system performance.

**Operating environments**

ADHER software is hosted simultaneously on three different environments: the Development Environment, the Staging Environment and the Production Environment. The Development Environment is used almost exclusively by the programmers and is constantly updated as new functionality is written into the software, or as technical issues (system bugs) are identified and resolved. Business users generally do not access the Development Environment as it is

![Diagram](image-url)

*Figure 3: ADHER is a Web-based platform accessed through a standard HTML web-browser.*
possible that new code or updates may cause the environment to be unstable or hang. Once changes to the Development Environment have been verified as appropriate by the programmer, the Staging Environment is updated with the new code. The Staging Environment is mostly accessed by the ADHER system administrators for the purposes of testing newly developed functionality and to check the resolution of bugs. It is also used for staff training. Issues in the Staging Environment are monitored by the ADHER administration teams and reported back to the programmer through a ticketing system. The Production Environment is the ‘live’ platform containing ADHER data and is accessed by the DCT team. When a team member encounters an issue on the Production Environment, the issue is reported to the ADHER Administrator and reported back to the programmer through the same ticketing system. Both the Staging and Production environments should be hosted on the same platform and server to ensure that an issue in Production is reproduceable in the Staging Environment.

The ADHER user interface
When considering the development of a software or platform the design of the user interface is critical and an issue that developers need to pay particular attention to during the early stages of development. A well-designed interface should be user-friendly, visually pleasing and provide a good balance between practical functionality and access to information.

Support in Arabic and English
ADHER is fully bilingual supporting Arabic and English languages, with the Arabic interface designed right-to-left and the English from left-to-right. Importantly both interfaces read from the same database to ensure there will not be any differences in information between interfaces. Once a record has been created in one language/interface, the same record may be opened and enhanced in the other interface. However, if attribute fields are completed in only one language, this attribute field will appear in both interfaces irrespective of the language. For example, if attribute fields are completed in the Arabic interface but not in the English, if the English interface is opened, the attribute fields will display the Arabic text. This functionality ensures that the user is always aware that fields have been completed rather than the system displaying an empty attribute field because the data is in a different language. Note that attribute fields with pre-defined picklists have been used wherever possible. This is because attributes in picklists can be stored as code and recalled and displayed in any language without a requirement for manual translation.
Figure 4: The finalised ADHER interface design with annotated functionality.
The main user interface
The interface displayed when ADHER is first opened has five main sections (Figure 4). Each section deals with different functionality. The first part is the Vertical Control Bar (VCB), which includes different widgets; the second part is a ‘Gallery View’, allowing the user to choose between the different base maps and historical images; the third part is a search bar; the fourth part is the navigation bar; and the final part is a layers panel, which contains a legend for the map layers and functionality for importing temporary layers.

Vertical Control Bar and the Data Search Results (DSR) window
Aligned down the left-hand side of the ADHER interface (English version) is the Vertical Control Bar (Figure 4). The first three buttons at the top of the VCB enable the user to select functionality relating to the main feature layers (Heritage Assets, Events and Designated Areas). Selecting one of these buttons (for example, the Heritage Asset records) opens the Data Search Results (DSR) window to the right of the VCB. The DSR subsequently provides the user with a summary of all Heritage Asset records. At the top of the DSR are filters that allow the user to filter out records of the sites not displayed within the map viewer (the eye symbol, Figure 5). The user can also display selected records within the DSR or see records that are filtered following a search. It should also be noted that records listed in the DSR are linked to and therefore dynamic with features displayed in the Map View window. As the user hovers over or selects a record in the DSR, the associated map feature is also highlighted or selected. Similarly, if the user hovers over or selects a feature in the Map View window, the associated record is highlighted or selected in the DSR.

Gallery view
Where base maps may be used on a regular basis, ADHER has a selection of preloaded base maps, satellite images and vector base maps. In addition, the gallery includes georeferenced historical satellite images, which help the user to understand land change over time and to investigate the history of a study area prior to field survey. In some cases, this can save significant amounts of time. For example, understanding the extent of reclaimed land may help to reduce survey areas and minimise time spent on field survey.

Vertical navigation bar
The vertical navigation bar provides the map navigation tools required to zoom in and out of the map, to select and unselect map features, and to identify the map features. A coordinates selector enables map co-ordinates to be easily selected, copied and pasted.
The layer panel
Within the right-hand side of the main interface is the map legend and map layers. This allows the user to select or unselect map layers and to control the visibility of map features. There are also options for freezing the layer and the option to change the colour palette.

Search strategies
For Historic Environment Records (HERs), it is not only important how data is entered but also how data is searched and retrieved. HERs include multiple types of information and resources, so the system must include options to search with different levels of complexity. Dynamic search strategies assist the user by filtering and displaying data based on how the user navigates the software. For example, as the user navigates to a desired area on the map, the DSR window displays a summary of records associated with features displayed within the Map View window. Included within dynamic search strategies, ADHER has three types of searches: the basic search, advanced search and period filter.

Basic search
The attributes and data returned during a basic search will depend on the tab selected from the VCB. For example, if the Heritage Assets button is selected on
the VCB, the search bar will automatically change to Heritage Assets attributes so the user may search by site code, title or any text from the summary, description or notes. Further searches are customised when the user selects Events, Designated Areas, resource types, people or organisations from the VCB.

**Advanced search**

To provide more options to find specific information, ADHER includes an advanced search functionality. This provides for Spatial search, Administration search, Keyword search, No Objection Certificate (NOC) search and a search using Structured Query Language (SQL) expressions. Search results are displayed in the DSR window and may be selected and exported in multiple formats.

1. **Spatial search:** The user may draw a point line or polygon within the Map View window to search for sites or search the map extent. The user can also specify the size of a buffer around existing or imported geometry to identify sites located within a specific distance from existing sites. This is particularly useful for searching areas of new development, for example, extracting all sites within the buffer zone of a new pipeline.

2. **Administration search:** The user may use the preloaded Municipality Administration layers to search for sites within a specific area. This enables searches within three municipality areas (Abu Dhabi – Al Dhafra – Al Ain), within specific locations within each area by using the Districts, Communities or plot layers or by using predefined DCT Areas.

3. **Keyword and NOC search:** A No Objection Certificate is required from each government entity when a developer submits a planning application to the Department of Municipalities and Transport (DMT). Of importance to DCT is the monitoring of legacy planning requests that have an archaeological or heritage condition. A Keyword search provides the ability to search for any text by selecting the appropriate tab in the VCB (Heritage Assets, Events, Designated Areas, NOC, etc.). As the system is integrated with the Municipality NOC system, the user can search for legacy NOCs by application number, reply date, municipality region or district.

4. **SQL search:** The SQL search provides advanced functionality for searching in ADHER. The user may specify a ‘clause’ or build queries by specifying more than one clause and linking them together. For example, to search for sites of international value with a specific site code, the user will add two clauses: The first will be for a site code that begins with ABCXXXX, and the second clause will be where the Cultural Value Index (CVI) is equal to International. This is one of many query examples available for searching based on the purpose and the selected tab in the VCB.
The period filter
ADHER has detailed records about heritage sites from multiple periods. The period filter details all periods from 145 million years ago to the present. The user may explore the heritage assets from each period by selecting one or multiple periods from the timeline, which provides an image and description of each period within the period filter interface. This displays filtered sites within the Map View window and lists filtered sites within the DSR.

Detailed record view
Each asset within the ADHER has its own detailed record interface that displays comprehensive information about Heritage Assets, Events and Designated Areas. Detailed records have two main interfaces, Browse mode and Editor mode. Browse mode provides the main attribute fields of the record without allowing the user to edit any of the fields. Browse mode includes a short summary, description, the type and period and many other details.
Editor mode allows users with editing privileges to open the main detailed record interface and review all the data associated with a heritage asset, event or designated area. The user may also enhance information or link resources, such as photographs, reports etc. to the record.

**Resources**

To enhance the information of the detailed record view, resources are linked with the records for heritage assets, events and designated areas. ADHER supports different types of resources, such as reports, GIS and Raw data, publications, finds pictures, site photographs and videos, audio and URL links. All these types of resources are classified into different tabs to organise and find data easily.

**Generating automatic reports from detailed records**

The assembling of data and the preparation of detailed reports, gazetteers or information requests using HER data is a routine part of the work that can be particularly time-consuming. ADHER provides the advantage of being able to assemble selected information from the attribute fields of detailed records into a predefined report template. For example, it is possible to use a specified buffer to search for sites within the distance of a geometry. These sites can then be selected and displayed within the DSR window. If the user then specifies a report with a specific template, ADHER will use the selected data to generate a report that can be exported in Microsoft Word and edited further based on requirements.

**Exporting and importing the data**

As the system uses geospatial data to visualise assets, it supports the export and import of data in multiple formats. For exporting data, the user specifies the individual layers and the extent of the area to be exported together while defining the output format and the spatial reference. The system supports the export of data as GIS Shapefiles, GIS Geodatabase, Google Earth KMZ files, CAD files and JSON files. Data can also be imported in these formats through the reference tab of the Layer Panel. When map features are imported through the Layer Panel, they are imported as ‘temporary map features’; however, they can be converted to permanent map features if they are linked with a detailed record. This option is particularly helpful when reviewing ADHER data together with external data. For example, it is possible to temporarily import the geometry of development proposals and then request the system to search for all sites within a predefined buffer around the development.
**Share maps**
ADHER supports map layouts based on a user specified location. A map can then be generated and exported using different layout templates and page sizes.

**Integration**
ADHER communicates with and displays data from other databases. These include databases held internally within DCT, such as EMu and the Inventory of Abu Dhabi Modern Heritage (IADMH) and databases held by external government entities including the No Objection Certificate (eNOC) system managed by DMT. Importantly, where data is shared with ADHER (rather than displayed), the original database continues to be the ‘single point of truth’ that updates ADHER. This is to ensure that there is no duplication of data or mismatch in data entry between the two databases.

1. **EMu:** A collections management software for museums developed by Axiell that includes information on the finds from excavations and other assets. Finds data is stored in EMu to avoid duplication and data conflicts. Communication between the systems is one way only, from EMu to ADHER. This provides the user with the option to review different finds together with their details and resources by using the site code as a unique identifier.

2. **IADMH:** A geospatial database developed by the Modern Heritage Unit within the Conservation Department at the Historic Environment Department at DCT. This system contains very comprehensive information about all modern heritage assets that are both inscribed and not inscribed. An API exposes ADHER to the important attribute fields of sites that are considered worthy of protection. When a site is inscribed within IADMH, the record and map features are updated to ADHER. While data is updated from IADMH into ADHER, IADMH remains the ‘single point of truth’, which means that when a record is updated in the IADMH database, the corresponding record is updated in ADHER.

3. **eNOC:** This provides data from the NOC system administered by DMT and enables ADHER users to review new planning and infrastructure proposals in relation to the geometry of heritage assets in ADHER. This enables a visual review to understand the situation and the conflict with the heritage sites in ADHER. Since the eNOC system receives more than 100,000 planning applications per year, business rules are set to filter legacy applications to only show applications that are assigned to DCT.
**Workflow data validation**
To ensure the quality of data entered into ADHER, a workflow interface is used for the validation of new data entered by the Historic Environment Department (HED) team. This includes the validation of new sites and resources that are added to the system but does not include temporary geometry added through the Layer Panel. Once the user adds a new site or resources, it is sent to the relevant unit supervisor for review and approval or rejection with comment.

**Mobile application**
Mobile applications are developed as a part of improving the field monitoring practices. This is particularly important within the area of the Al Ain World Heritage Site. The ADHER mobile applications provide the ability for HED rangers to record, report and update ADHER regarding the condition of sites. A dashboard within ADHER manages all the field activity and schedules rangers’ routes and workloads for each week. Information gathered by rangers is reported to the relevant supervisor within the dashboard via the ADHER mobile application.

**Future development**
Although ADHER has many functions, continuous development is planned over the next few years, as there is no limit to how the system may be enhanced. In particular, it is important to ensure that ADHER is supported and is compliant with updates to other software packages. The main developments will focus on the following issues:

1. **3-D models of heritage sites:** The HED team already use photogrammetry to record and produce 3-D models of heritage sites. This improved methodology for recording and visualisation should be reflected in the way that ADHER displays data. ADHER aims to provide information about sites, and 3D models will be enabled within the Map View window in ADHER for displaying heritage sites. In order to complete this step, the system will be upgraded from JavaScript 3 to ArcGIS Maps SDK for JavaScript 4.

2. **Public Web Interface:** Part of the ADHER objective is to disseminate information about the heritage sites of Abu Dhabi to the wider public, researchers, teachers and people involved in higher education. For this purpose, a light version of ADHER will be developed for public access. This will involve some screening of data from the ADHER database. This is because there may be sensitive sites that can be damaged through unsupervised public access or issues around copyright for the distribution of images etc.

3. **Survey application:** As the ADHER has a mobile application for monitoring existing sites, a new application will be developed to support archaeological
fieldwork. This will enable archaeologists to survey monuments and enter the details directly into ADHER as data from new sites is being recorded. This will include the ability to see the existing sites and add new sites using smart devices.

**Discussion**

By developing ADHER, DCT has created a robust backbone and user-friendly online portal for storing and managing geospatial and non-geospatial cultural heritage information. The system facilitates easy access, search and query functionality of Abu Dhabi cultural heritage information by both core system users (the Historic Environment Department) and other users within and external to DCT in accordance with each user’s role and access privileges.

However, the development of a software or appropriate system for the storage and retrieval of heritage data is only one part of the development and curation of data. A second and equally challenging part is data research, development and the entry of legacy data. DCT is currently in the early stages of an ambitious digitisation programme, involving the scanning and archiving of large amounts of paper-only and dispersed digital reference material that is currently held as legacy data. The programme involves the transfer of paper files to digital media and the creation of new and enhanced records within DCT. As for any database, the system only becomes effective and powerful once a meaningful level of data has been entered and data can be purposely retrieved.

As with any software platform, the system requires maintenance and support. This is not only to resolve the inevitable bugs that arise within the system, but also to ensure that the system remains up to date with changes in both software and hardware architecture. As with any database, the curated information requires review and updating to ensure that information is relevant. An effective data management process is important because it ensures that the information is accurate, reliable and as up to date as possible for everyone who needs to access it for analysis, reporting and making business decisions. However, such a system is invaluable for assisting heritage managers in understanding the extent, location and importance of heritage, while assessing threats and providing informed, knowledgeable advice for planning control.

Finally, while it remains the responsibility of every region to manage their own heritage data, many of the principles and concepts used for the development of ADHER are transferable to other regions, and with minor modification, the software could form the basis of a robust platform for heritage management and support in other regions, particularly within the Middle East and North Africa region, as much of the Arabic front end and thesauri have been extensively developed.
Bibliography


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