An approach for the integration of central and on-site conservation systems

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HU ISSN 1418-7108: HEJ Manuscript no.: INF-030530-A

Abstract

Most of the heritage conservation information systems should be reorganized, since they don't exploit new information technology and management possibilities, so they cannot reach better quality of service, operational safety and cost-efficiency. Before implementing new information management solutions, it is recommended to analize the current IT solutions and to perform the revision of the division of labour between the central and on-site organizations. This paper collects conserderations that can be used for the renewal of national conservation information systems. However the focus is on the inter-organizational connections and the division of the work, the issues of the innerside system integration are also mentioned where it's needed. This research attempts to introduce a method to find the optimal composition of the conservation management activities for better system performance. It can be later used in planning of concrete national conservation systems for organizing the divison of work.

Key words: Conservation systems, integration, on-site, heritage

1 Introduction

The heritage conservation information systems have various state of development and most of them, even the ones of the UNESCO World Heritage sites, don't exploit the new IT possibilities. States usually have central organizations that manage heritage sites of the country, cultural and natural sites are often handled by different central orgranizations. The developed method assumes that heritage sites (e.g. national conservation areas, museums, etc.) have individual on-site conservation subsystems.

The desired integrated system includes a central and the connected on-site subsystems. This study observes the issues of IT system integration among these subsystems. Central subsystems are international and national (regional) organizations with authority. Some site-related activities are worth to be done centrally, while others are typical on-site activities, these remote subsystems usually manage similar information. To reach better system performance, the subsystems should be integrated, using new IT solutions. The study gives several considerations that may help to decide what activities are worth to be done centralized or decentralized.

Despite the focus of this paper is on the need of centralization, there are also discussed some problems considering how to resolve the integration inside the central and on-site information systems.

The showed method attempts to divide typical conservation activities (sub-processes) among the two sides of the connection, optimizing the cost/performance rate, assuming that integration can be established between any two subsystems on both sides.

Unfortunately integration is usually not supported perfectly by each sub-system, so the current possibilities and the different quality levels of the integration are also collected and discussed in this study.

2 Background

Previous researches were taken to collect the key processes in the heritage conservation information management systems in 2002, as a part of the ICHEPIS project [26] *(Inventorisation for a Cultural Heritage Periodic Reporting System - Development of standardized database model for integration of the UNESCO World Heritage Periodic Reporting System and the National Heritage Conservation Information System).* This research resulted the list of short descriptions of the typical processes of the heritage conservation systems.

Additional researches of the project ICHEPIS tried to collect the data-management considerations for some of the most commonly used input data-sources in the heritage information systems.

Processes in conservation systems should use new IT and information management technologies. Business Process Reengineering concerns the fundamental rethinking and radical redesign of business processes to obtain dramatic and sustaining improvements in quality, cost, service, lead time, outcomes, flexibility and innovation [2]. The same article discusses and introduces a conceptual model to illustrate the role of IT in BPR. It also presents a conceptual model and strategic framework for BPR.

The renewal of information management system requires changing also in strategy. Hannu Salmela and Ton A.M. Spil [3] introduced a suggested method to formulate and implement information system strategy in dynamic and emergent context. The four cycles-method combines the strengths of both the comprehensive and incremental planning to be able to recognise emerging trends and to make an e-business strategy.

Conservation information systems may include GIS (Geographic Information System) and CAD (Computer-Aided Design) system support. In CAD systems plans of facilities can be created and later modified, these plans can be easily used for Facility Management purposes. These supporting systems are in continuous advance, the functional integration in CAD systems is discussed in [20]. It examines the issue of integration in CAD systems and argues that for integration to be effective, it must address the functional aspects of a CAD system. It also discusses the need for integrated systems and identifies several facets of integration that should be targeted.

Marketing in heritage sites has accentuated importance. Jean- Michel Tobelem [6] presents the factors of introducing marketing in museums.

2.1 Risk and catastrophy management

Risk and catastrophy management in conservation systems has accentuated importance.

Considerable literature has grown up around the demand for 'Disaster Plannin' by all institutions [7], not least the Getty Conservation Institute's substantial publication Building an Emergency Plan (1999) [8].

E. Cagno, A. Di Giulio, P. Trucco [9] highlight the main objectives and constraints on the planning phase of a safety improvament program. Three objectives have been identified: risk reduction, clustering of measures with homogenous or compatible characteristics and minimalisation of the overall disturbance to the production system (inefficiency) over the program time span. On the other hand, three different constraints have been considered: limited availability of resources, incompatibility in the implementation of measures and limitations on plan acceptability (economical, technical and organisational limitations).

Integration between business planning (BP) and information systems planning (ISP) is crucial for the information systems (IS) function to more effectively support business strategies. William R. King and Thompson S.H. Teo [15] examined two modes of ISP, reactive and proactive. In Appendix A. a questionnaire is showed to present the possibilities of BP-ISP integration: administrative, sequential, reciprocal and full integration.

Conservation information systems may include off-the-shelf subsystems, e.g. Enterprise Resouce Planning (ERP), Facility Management, Building Automation Systems, etc. ERP system implementation has the most widespread literature.

Purnendu Mandal and A. Gunasekaran [16] introduces a case study using the change management strategic considerations [17] including pre-implementation, implementation and post- implementation strategies.

Several further studies relating to Enterprise Resource Planning (ERP) systems were also studied. Palaniswamy Rajagopal [18] presents an innovation-diffusion view of implementation of ERP studying three types of ERP systems: SAP, Baan and Oracle ERP. Implementations of ERP systems was found to follow the stage model.

3 Approach

In the time of writing this paper the national and on-site conservation management systems have rather low quality information system assistance. Generally most of the management activities are still paper-based, only some activities have IT- support.

This paper includes some recommendations for the renewal of the conservation information systems (IS). IS can work properly and cost-effectively in the same time if there is computer-system support and system integration among IS-s.

Computer-aided systems are preferred mostly in those well automated areas where much information is managed, e.g. for Facility Management activities or by the registration of objects under conservation. System integration needs inside and among the central and on-site conservation subsystems.

In this study the conservation information management system processes are also introduced and analyzed. The considerations may help to decide whether to organize the individual conservation activities centralized or decentralized. This paper shows a developed method to find the optimal composition of the conservation management activities to reach better system performance optimizing both the quality of service and the cost- efficiency.

A functional approach was applied to collect the advantages to be solved by the IS. In the feasibility or planning phase of an integrated national conservation system first there is a need to determine for each existing and possible future on-site and central subsystems the required functionality and the division of work.

Processes relating the heritage sites can be classified into typical and non-typical cathegories, the typical ones are such key and supporting activity areas that should be implemented in conservation information systems, while the rare non-typical processes are generally site-dependent particularities. Typical processes are collected by previous researches in the project ICHEPIS [26]. For optimization purposes only these processes are relevant, since site-dependent "non-typical" activities are usually separated on-site activities, with no need and connection for centrally collected and stored information, it is appropriate to discuss the issue of decentralization only on "typical" conservation system activities. Therefore the maximal conservation system functionality is limited, and theoretical model of conservation systems can be composed.

There is governmental duty to collect and manage certain information centrally, and there are some additional activities that are suggested/worth to perform centralized. Central organizations are in connection with all on-site subsystems, therefore central information systems should be planned considering the contiuously changing requirements of present and future on-site information systems.

It is a rather hard problem. Probably the division of work among central and on-site systems has no significant difference in different countries, however the differences of regulation may inducate some variance among the national information management systems. Pilot national systems with full documentations, recommendations and personal meetings are suggested for more successful implementations.

The minimal proper functionality is determined by the regulation. Additional functionality or better supporting activities can improve the quality of conservation and operational safety.

During the planning of the national system, the purpose is to find the optimum between minimal and maximal functionality, where minimal functionality is determined by the legislation and international organizations while maximal functionality means the previously collected "typical" conservation activities.

This paper shows a method to determine which activities are worth/suggested to be implemented decentralized in such theoretical national conservation systems that includes on-site subsystems with maximal functionality. Later it can be used in planning of concrete national conservation systems for organizing the divison of work.

4 Methodology

Initially typical conservation system processes and the current possibilities are discussed for successfully implementing the connection among central and on-site subsystems. In the next step there is an attempt to determine for each function and their sub- processes (each process step-by-step) how they individually worth/suggested to be executed: centralized or decentralized.

Unfortunately sub-processes are connected and can influence each others. To reach high system performance, processes need additional refining. The optimum should be found reckoning several requirements: the need for minimizing the amount of communication and operational costs, meanwhile not blocking human communication to support better decisions, and to achieve proper service-levels, including adequate reaction times, effective actions and status-monitoring, etc.

Therefore sub-processes should be further refined considering the connections among them and the requirement of optimizing the communication costs among the central and on-site information sub- systems.

Additional information should be collected for each sub-process to determine if it is possible or worth to support the given functions with computerized systems. In the next step a decision should be made on concretely which information systems will be used and integrated considering the possibilities of the inner subsystem integration on each side.

Several studies collect arguments that may help to decide whether to develop a new subsystem or customize a chosen off-the-shelf system. However these considerations were made only for Enterprise Resource Planning (ERP) systems, similar principles should be used in purchasing the other sub-systems.

Before creating the feasibility study, the following issues should be answered:

- Which sub-systems are constraint/fix systems? (that are hard or impossible to change),
- Which sub-systems support integration? (necessary integration with other sub-systems from either the same or the other side of the connection),
- Which activities can be supported with IT?
- Which functions/sub-functions can be supported by customized off-the-shelf or already implemented available sub-systems.

5 Information Technology software solutions

The chosen type of connection should reach proper speed (data- processing and reaction times) and low data-exchange costs. The comparison can be approached from both functional and system solution views, including IT and economical optimization.

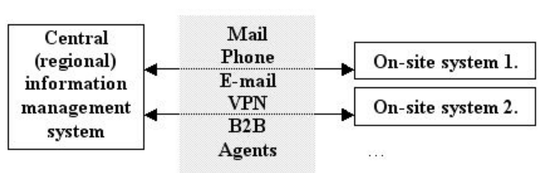

Figure 1: Communication between central and on-site heritage subsystems

Mail and phone are currently the most frequently used kinds of communication to bind central and on-site conservation information systems. They do not support new IT-automation methods, which could reduce the need for human influence during the database synchronizations. They probably remain an important part of the information systems, since they support informal connections and fast reaction-times when exceptions occur, permitting *ad hoc* decision making. Implementing new information management systems based on IT may reduce the amount of unnecessary *ad hoc* decisions.

IT-solutions also can be classified on both sides (empirical classification considerations):

- *Type of database*: electronic or paper-based databases,
- *Type of management system*: management system with or without IT-support,
- *Database synchronization*: Automatic, controlled automatic or non-automatic database synchronization (only computerized systems).

Controlled automatic database-synchronization protects against wrong data-changes on the other side of the connection, so errors can be easily localized by filtering.

If human communication also needs to be supported, computer and phone-based devices should be used. Computer tools can support group-working on various levels (via e-mail or groupware solutions). Some aspects of Group Support Systems (GSS) are discussed in [23], [24], [25].

In the currently used system there is no computerized data- exchange between the central and on-site information systems.

5.1 Database mirroring and database synchronzation

Real-time far connections are rather expensive between two sub- organizations, neither that with computerized or non-computerized subsystems, so it is currently not an adequate solution. Instead it is recommended to apply systems that reduce the amount of communication.

The amount of communication is a critical issue. It means that centralized operative database requests are to be reduced, (e.g. by mirroring), but human communication (e.g. e-mail, phone, group- working, e-talk, etc.) should be supported.

Between the central and on-site systems that pass on not-human messages, it is suggested to transmit only changes, to reach proper database synchronization. It can be done manually (e.g. database changes are sent trough via e-mail that can be loaded on the other side by system administrators) or automatically (when database changes on any side, it also initiates database synchronization).

5.2 Daemons, Services, Software Agents

Daemons, services and the software agent technology is the useful solution if the integration is not supported by the subsystems. They are autonom softwares, the integration can use them for several purposes, they can perform additional data-processing and database synchronising: they collect information from any database and fill it into another database(s). Unfortunately, these solutions have limited possibilities and are rather expensive, since require much additional programming. These technologies are usually applied in such systems where the possibilities of customization are limited, additionally both input and output subsystems' databases should be accessible by third-party applications and properly documented.

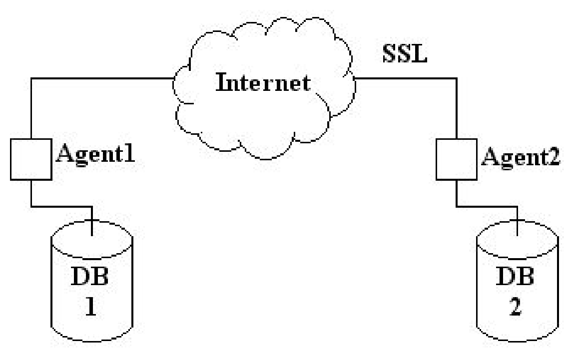

Figure 2: Integration using agent technology (example)

The main problem of these software is to sense database changes. If database management systems don't support sensation of such events, they usually should poll the databases to determine whether changes occurred, but it may leads to slowing of the database.

5.3 B2B, B2C and XML

Increasingly, the Internet is acting as a communication tool between business partners, which needs a common language of communication inside and across enterprises. XML (Extensible Markup Language) shows promise as this communication medium. XML provides a vendor, platform, and language neutral technology for distributing data across both public and provate networks, and so it has gained wide support from ERP vendors including SAP, PeopleSoft, and others [11]. Another publication discusses [10] the impacts of XML on B2B and B2C (Business-To-Business and Business-To-Customer) commerce.

Since the integration of the central and on-site information systems (IS) is a kind of Business-To-Business connection, it's suggested to use XML and B2B also in heritage information systems.

5.4 Information Management, Project Management

5.4.1 Participation

Usually the system is planned for normal usage, but rarely some problems require common work. This time the better decisions and performance require the personal meetings from both the central and on-site sides of the connection, but sometimes computerized IT-tools and telecommunication devices could give enough support for group-working.

It's hard to find the optimum-point between centralization and decentralization. Unfortunately this optimum-point is changing continuously, so an "optimum-range" also should be determined in system-planning time.

5.4.2 Coordinating the communication

In distributed information management systems organization of the coordination is always a critical issue. Cost-efficiency and operational security can be achieved if the advantages are exploited on both human and machine levels, but it is hard to reduce the coordination and operational costs in the same time. For proper integration both side of the connection must be well- equipped.

6 Analysis of typical processes in conservation information systems

Heritages and conservation systems are varying, they manage different kinds of information. Among other factors the type of the site, law, information management habits (culture), costs, budget and several other considerations influence the range of currently managed data in the conservation system.

By the definition of the UNESCO World Heritage Center (1972, Convention Concerning the Protection of the World Cultural and Natural Heritage [21]) the type of site can be one of the followings: natural, cultural or both, however the showed model and methods can be applied on heritage sites that are not nominated for the UNESCO World Heritage List.

Site conservation systems on natural sites [21] usually manage great territories, e.g. national parks, so site information systems are focusing on both object and ecological data (flora, fauna and by species some additional informations: dispersion and number of individuals, risk, etc). And there are some buildings that are either parts of the conservation site, supporting facilities or other buildings that are not under the management of the conservation system (e.g. houses in a town inside a national park). Cultural heritage [21] conservation systems manage merely facilities with remarkably fewer outer territories than natural sites.

In Hungary information of cultural heritages are collected in the national (central) heritage information system, but the natural heritages are not collected centrally or this information are managed by more organizations. Another issue whether these organizations have electronic or paper-based databases.

The on-site information systems are even more various, therefore the approach should be established from functional point of view, not assuming IT support in the management system. There are remarkable differences among on-site subsystems in functionality and information management support. Usually theoritical functionality is not implemented fully in conservation systems. It means that not supported functionality is performed with ad hoc decisions.

6.1 Classification of the processes in heritage information systems

It is suggested to divide heritage system processes and problems into two or three groups according whether it's practical to execute the sub-processes centrally or on-site. However need for speed of the data-processing seems to require it, redundantly conducted data-processing algorythm with the same inputs both sides should be eliminated, because in long-run it may lead to inconsistencies (e.g. when the costly or slow data-transmission and processed information transmission would require more money and/or time).

Those processes that are suggested to be implemented centrally, usually either

- require highly educated persons wit special knowledge, or concentration of such people (e.g. for central decision making or to handle exceptional changes, to perform brain storming, to develop of new processes, etc.),
- it's worth to collect data together,
- economy of scale: larger operational and storage (human and machinery) capacities,
- better safety and security,
- reduced coordination costs,
- etc.

Decentralization is preferred

- if problems can be conducted only on the place (measuring, reacting, etc.) or
- to decrease the capacity needs for the central system or the transmission network, or
- the centralized solution could not assure the desired reaction-times (safety and security),
- etc.

6.2 Centralization/decentralization of typical processes in the conservation system

6.2.1 Processes relating the central registration system of objects under conservation

Nowadays decentralization and empowerment are wide-used methods. National conservation registration system requires the existence of a centralized part of the information system, since there is a need for a national ledger of objects under conservation. On-site systems may include mirrors or partial mirrors about this central subsystem. It is suggested to administrate central activities in regional offices that may have integrated information systems.

There are processes for recording the collected information about the sites, art objects, monuments, etc. Since all the research information updates the database, this activity needs IT support.

With the improving of the IT systems GIS and CAD systems (Georgraphical Information System, Computer-Aided Design) support can be implemented to store where the given site (art object, monument, etc.) can be found on the map or plan.

All the information that is stored in the central database (either the information of the registry of objects under conservation, GIS or CAD system are needed on-site) should be passed on for the on-site Facility Management system.

6.2.2 Facility Management processes

Facility Management systems handle the whole site as a facility, so this subsystem requires and manages different information than the registry of objects under conservation, however there is some overlapping. Facility Management systems handle even such objects that are inside the conservation area, but are not under conservation. Between these subsystems proper integration should be implemented.

Operative Facility Management activities and the supporting IT system usually should be controlled and executed decentralized, while strategic FM-processes can be left either centralized or decentralized. Decentralization assumes proper knowledge and empowering from the management on the site.

Some steps of operative FM-supporting processes (e.g. collection of air and radar photos) are done by central organizations.

The International Facility Management Association (IFMA), the professional association for facility managers, has grouped these responsibilities into several major functional areas [1]:

- long-range and annual facility planning,
- facility financial forecasting,
- real estate acquisition and/or disposal,
- work specifications, installation and space management,
- architectural and engineering planning and design,
- new construction and/or renovation,
- maintenance and operations management,
- telecommunications integration, security and general administrative services.

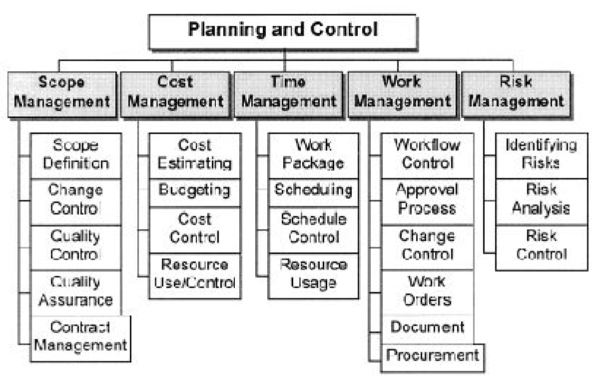

Figure 3: Planning and control [19]

In the hierarchy of the IAI FM functions and their processes are generally considered to have two funcdamental aspects: first, a general governmental planning and control function (see Figure 3), and second, a specific or identifiable FM function (see Figure 4) [19].

6.2.3 Centralization/decentralization in the operational input information management process

The model in Figure 3. shows the possibilities of input data- management. Data transmission is enabled among and inside the sub- processes of the data-management process. In heritage management systems input data usually relates to object state information.

In the ICHEPIS project previous researches aimed to make recommendations for the management of the most frequently used data-types: aerial and radar photos, maps, textural and other multimedia

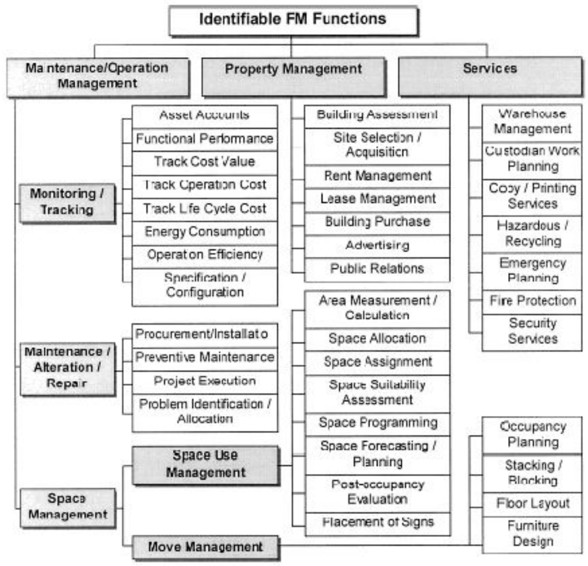

Figure 4: Identifiable FM functions [19] (IAI North American Facilities Management Domain Committee)

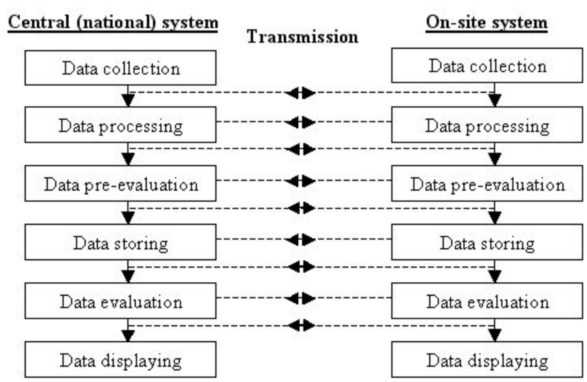

Figure 5: Possible data transmission points between the central and on-site systems in the operational input information management process

formats. These recommendations are focusing mainly on the technology processes, and don't include any suggestion how to organize the division of labour between the on-site and central (national) information management systems.

- *Data collection* is a typical on-site activity, but some kinds of data (e.g. radar photos) originates far from the site. The authority for making such expensive commissions is usually owned by central systems. Information systems frequently collect object status-related and economic information. They can be done periodically or not, manually or automatically. Building Automation Systems (BAS) can also be used for such purposes (In article [22] the possibilities of integration BAS and Facility Management systems are analized).

- *Data processing* and *pre-evaluation* phases prepare information for storing in (manual or electrical) databases from the collected data-sources. They analyze and transfer the collected information for storing and supporting later examinations. Both specialists and data processing IT subsystems can be used for thorough preparation.

- *Data storing* is for storing data in the database systems.

- *Data evaluation* and *displaying* phases initiate queries in the databases and display results on the screen.

Decision must be made on how to execute the individual phases (and sub-phases) of data management process: centralized or decentralized. It is influenced mostly by the following factors:

- Reaction-time requirements,
- Special knowledge requirements,
- Economy of scale,
- Data transfer costs,
- Law and/or rules,
- and the need to keep the connection between on-site and central IT systems.

Additional IT-factors with highest influence are the followings:

- Storing (database-mirroring requirements),
- High communication costs between the central and on-site subsystems.

6.2.4 Reporting

Inter-organizational communication can be classified into human and IT-system communication. Human communication is usually supported by the IT system, either by phone, e-mail or groupware systems. There is demand to formulize at least a part of the human communication. Forms should be used among the organizations to ensure the level of reporting in long-run.

Global integration is required to implement integrated communication with international organizations. It means that every contry uses the same forms for reporting. Usually national organizations have the authority to communicate with international organizations, therefore generally there is no direct communication between the on-site offices and international organizations. E.g. the UNESCO World Heritage Sites should make periodic reports, they send it into the national World Heritage Secretariat, and after a revision they pass these reports into the UNESCO World Heritage Center.

Reporting should be supported by the systems on both side. Computerized systems may support electronic forms that can be sent trough the internet.

There are periodical, extraordenary and other kinds of reports. Their purpose is rather various. Reports should include the more formulated fields for later electronic processing, but additional fields are necessary for recording the notes.

It is not good if there are some sites that use paper-based, others use web- or e-reporting and another sites may don't report in the same country. It is another problem if there are different reporting forms used in the same system.

Maybe the uniformization of the reporting forms should be started and controlled from international level. Additionally, national central information management systems should not use different reporting systems, inter-organizational messages and interfaces in the communication. New IT solutions should be supported and implemented.

6.2.5 Tourism, marketing and related quality management, ERP on sites

Tourism is an important part of the information system on heritage sites. Tourism management and conventional ERP systems are the most frequently used subsystems that should be integrated with the kernel of the conservation system that includes Central Repository System for objects under conservation, Facility Management (FM) system and their input information collectors and data-processing subsystems. These subsystems may include Building Automation Systems (BAS), as it mentioned above. The kernel of the new conservation systems may include web-server for public, scientific or inter-organizational communication via Internet, intranet or extranet. Sometimes integration between some subsystems can be implemented only using web-services. FM systems usually need the support of CAD and/or GIS systems to design and manage spatial information. Tourism information systems, ERP systems and IT supporting activities (e.g. system administration) should be connected with the kernel of this system.

The tourism industry is undergoing significant restructuring [12]. The combination of mass and concentional tourism has so far formed the major part of the organized tourist business, with non- mass alternative tourism having the smaller part of the pie.

The strategy of sites is the more influenced by the tourism. A case study is introduced in article [13] showing how to develop the strategy for a concrete UNESCO World Heritage site describing zoning and environment management planning and tourism development guidelines.

Brian Garrod, Alan Fyall has summarized the major constraints and imperatives relating to the long-term management of built heritage attractions [14]. Up to now the management of quality in destinations in relation to competitiveness has received very little attention [4]. Publication [5] discusses the role of integrated quality management and conducts a comparative survey of coastal destinations and urban destinations acrross European Countries, with the application of the EFQM (European Foundation for Quality Management) model.

Tourism information system functionality is remarkably connected with the Facility Management (FM) subsystems'. Heritage conservation is a typical governmental activity, while tourism is typically performed with significant interest of the private sphere.

Similarly to the suggestions relating the FM processes, operative tourism and ERP activities are suggested to perform decentralized, only the strategic and long-term planning subsystems should be left centralized. Additional IT system maintenance processes like system administration should be executed both side. These activities may worth to be done outsourced.

There are several similar and opposing interests in FM and tourism strategies. E.g. while tourism would like to accept more visitors to realize even more profit, conservation systems may determine the maximum visitors per year. There is a need to spend a part of the profit of tourism on the heritages, however in some cases facility investments may expand the capacity of the monuments. Another issues of tourism, like tourist accomodation are also discussed in [13] for the Angkor UNESCO World Heritage Site in Cambodia.

7 Conclusions

This article describes a new approach to the renewal of national heritage conservation information management systems. It analizes from functional point of view the division of work between central and on-site organizations for better system performance, and gives a recommondation how to reach the optimum in the beginning of the system planning phase. The resulting considerations discussed in this paper may be used later to construct the model of central and on-site heritage information management systems.

Acknowledgements

The author would like to acknowledge the valuable help we received from Royal Angkor Foundation representative János Jelen and Hungarian Administration of Cultural Heritage director Dr. Dénes Jankovich-Bésán, the Graphisoft R&D director Tibor Seidl, Dr. Péter Gelléri and Dr. Ferenc Kiss from the Budapest University of Technology and Economics Department of Information and Knowledge Management.

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