

The Hellenic Cadastre: Use of Modern Technologies to Develop an IT and Data Infrastructure to Facilitate Large Scale Cadastral Survey Procedures

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Key words: Cadastre, Hellenic Cadastre, cadastral survey, IT, data infrastructure

SUMMARY

This paper describes the major technologies and management approaches that have been adopted recently in the Hellenic Cadastre to facilitate the data collection and validation procedures. Indeed, in an effort to ensure that the selected data will have a specified quality level, reduce the risks involved in carrying-out large scale cadastral surveys and reduce the data collection and validation costs, Ktimatologio S.A., the agency responsible for the development of the Hellenic Cadastre, has adopted a wide range of state-of-the-art technologies, such as, permanent GPS stations, high-tech aerial photography and Web-based services, to achieve those goals. All these technologies are integrated appropriately to support the implementation of a series of large-scale projects that aim to develop a spatial data infrastructure for developing the Hellenic Cadastre. The paper will describe the set of those projects and will explain the philosophy that underlies them. Also, the paper will present the progress that has been made in the implementation of those projects so far and the steps that will be made in the future to complete those projects. Finally, the paper will make a critical assessment of the issues encountered in the course of the implementation and the actions that have been taken to overcome those issues. The lessons learned from this process can be very useful in other settings, where either new land administration systems are developed or existing systems are upgraded.

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1. INTRODUCTION

The Hellenic Cadastre is a system that aims at registering all properties and property rights in Greece and keep the related information always updated (HEMCO 1994, Potsiou *et al.* 2001). The updating and the validity of the data after the initial registrations is a responsibility of the Greek State. This system was designed to replace the existing system of “*Registries and Mortgages*” of deeds that operates in Greece since the 1850’s and it has several deficiencies that do not allow the effective functioning of land markets in Greece. In particular, the system aims at providing all relevant property information in a concise manner so that an individual who is interested about a property will be able to access all related data and documents easily. This facility was not supported by old system of “*Registries and Mortgages*”, where the information was stored in chronological order of the registered deeds and was indexed only by the name of the owner or the beneficiary of a property right and not by property. The second major improvement that the new system makes is that, after the finalization of the initial registrations, it provides security to those who make land transactions based on the data maintained by the system. The old system could not guarantee that. Instead a person, who had lawfully acquired property rights, could face disputes or even loose his/her property, if someone contested those rights bringing out valid titles. Finally, a third major improvement that the new system makes is that, if a property is registered and depicted on a cadastral map, then it is always possible to locate that property on the ground. That capability was not supported by the old system because the information about a property and its location was in almost all cases descriptive on the deed and not cartographic. As a consequence, many properties, particularly in rural areas, cannot be located on the ground, although they have been registered in the system.

In order for the new system to be established, there was a need, among other things, to collect and validate the data about properties and property rights in Greece. This task was achieved through a data collection and validation procedure specified by Law 2308/1995 (Hellenic Republic, 1995) and the implementation of a series of large-scale cadastral survey projects that, sequentially, would cover the entire country (Lolonis 1997, Lolonis 1999, Lolonis 2004). The first three (3) series of cadastral survey projects were launched in 1995, 1997 and 1998, respectively, and covered 340 municipalities (6% of the country) and a total area of 8,400 Km² (approximately 6,3% of the country). All three (3) series of projects are now at a stage of completion. In fact, the data collection and validation procedure has been completed in more than 85% of the municipalities included in those projects and the cadastre is in operation in those municipalities.

The implementation of the first three (3) series of cadastral survey projects indicated several issues that had to be accounted in the design and implementation of the subsequent projects. First, there were substantial delays in the implementation of those projects because, among other things, the property owners did not know the procedure that they had to follow and they needed time in order to learn it and file their declarations. Also, there were delays in the projects because the magnitude of the involved work was underestimated, extra tasks were added (e.g. compilation of forest maps to secure the State's ownership rights on forest land), and the time required to judge the objections, as well as, to perform quality control of the data was longer than originally anticipated. Finally, there were substantial budget overruns, primarily because of the increased amount of work that had to be done and the longer periods of time required by the projects to be completed. All these issues prompted the Greek, as well as, the EU authorities, which were at that time the primary financial sources of the projects, to re-evaluate the procedure and explore alternative ways that would reduce costs and improve the effectiveness of project management.

After a fairly long period of negotiations and after close cooperation of the Greek and EU authorities, a new Operational Plan was developed for the next series of projects that could be co-financed by them (Ktimatologio S.A., 2004). Those projects did not aim at the establishment of a cadastral system in new areas in Greece, as it was the objective in the first three (3) series of projects, but, instead, they aimed at the development of the appropriate geodetic, data, and information technology (IT) infrastructure that would be used as a foundation for the subsequent stages of the cadastral survey procedures. This way, it was envisaged that the problems encountered in the first three (3) series of projects would be ameliorated and the new projects would be better controlled and managed. The Operational Plan has a total budget of 79,67 million Euros and was incorporated as "Measure 2.9" of the Operational Program: "Information Society" of the Community Support Framework III.

In this paper, we present briefly the underlying philosophy of the new Operational Plan and describe the set of projects that comprise it. This description will be made in the second section of the paper. In the third section, we describe the current status of the projects. In the fourth section, we discuss certain issues that are related to the implementation of the Plan. Finally, in the last section, we sum-up the conclusions of the paper.

2. THE OPERATIONAL PLAN OF THE HELLENIC CADASTRE FOR THE COMMUNITY SUPPORT FRAMEWORK III

The Operational Plan that was incorporated into the Community Support Framework III for co-financing by the Greek State and the EU has a title: "Data and IT infrastructure for a modern cadastre" and consists of eleven (11) main projects (Ktimatologio S.A., 2004). Those projects are classified into five (5) main domain categories, each of which covers a particular component of the infrastructure. Thus, the first domain covers the development of the necessary geodetic infrastructure, which would facilitate not only the collection and validation of the initial registrations, but also the surveys that will be made after the beginning of the operation of the cadastre in an area. The second domain refers to the

collection, digitization and computerization of data that are stored in the archives of State agencies and are useful as evidence in the cadastral surveys. Such data are the land consolidation and land distribution data that are archived in the Ministry of Rural Development and Food (former Ministry of Agriculture) or the cadastral data, which are stored in the archives of local cadastral offices that operate, as exceptions, in certain areas of the country (e.g. Dodecanese). The third domain refers to the base maps that must be used to delineate the properties identified during the cadastral survey procedure. The fourth domain refers to the data about certain categories of public land (e.g. forestland and shore) that must be protected from potential infringement during the cadastral survey procedure. Finally, the last domain pertains to the IT infrastructure, which would enable Ktimatologio S.A. not only to manage the collected data and disseminate them to its users and collaborators but to operate the cadastre effectively, as well.

The major drives that underlie the development of such a Plan that separates the above domain activities from the remaining activities of the cadastral survey procedure are the following. First, there is an objective to remove at an early stage as many obstacles as possible from the cadastral survey procedure. In the past, such obstacles have caused delays, errors, and uncertainties in the cadastral survey projects. Indeed, the fact that the forest areas had to be delineated as part of the normal cadastral survey procedure had caused delays in the implementation of the cadastral survey projects because the forest maps had to be prepared and submitted for inspection to the local Forestry Departments before the procedure could finish. In addition, there were delays and increased costs due to the objections that had been submitted about ownership of forestland either by individuals or by local Forestry Departments at a very late stage of the procedure. All these issues, which apply to other kinds of data, as well, can be ameliorated, if they are separated from the main procedure and are carried-out independently and in advance.

The second drive for structuring the Plan as a set of “horizontal” projects that would be carried-out at the national level was to reduce costs by exploiting new technologies, specialization efficiencies, economies of scale, and synergies among the projects. Indeed, the marginal cost for compiling orthophotomaps at the national scale is substantially smaller than the cost of compiling such maps at the local scale. Similarly, implementation of a project at the national scale would enable use of technologies that are very effective at that level, while the same level of effectiveness cannot be achieved at the local scale.

All the above concepts were synthesized into a single coherent plan in order to implement the development of a data and IT infrastructure for a modern cadastre. The individual projects that comprise the plan are described briefly in the sections that follow.

2.1 Modernization of the geodetic infrastructure by developing the Hellenic Positioning System (HEPOS)

The project aims at modernizing the geodetic infrastructure in Greece and upgrading the services of determining the geodetic coordinates of any location in the country (Gianniou and

Mastoris 2006a, Gianniou and Mastoris 2006b). Specifically, Ktimatologio S.A. will deploy a system of permanent GPS stations, connected to a central Processing Center, that would enable users to compute, in real time, the coordinates of their location with an accuracy of few centimeters (2-6 cm) using a single GPS receiver. This system will be called the “Hellenic Positioning System - (HEPOS)” and it will be comprised by approximately 100 permanent GPS stations uniformly located all over Greece. Those stations will be receiving continuously the signals from the GPS, Glonass and, in the near future, Galileo satellites, and will be sending them, though telecommunication means, to the Processing Center. The Center will be processing the signals and will be computing the corrections that would be sent to the users in the field, so that they can determine the coordinates of their location with very high accuracy. The delivery of the corrections will be made through widely available telecommunication means.



Figure 1.

Accurate measurements through a system of permanent GPS stations. Users in the field, using the appropriate devices, will be connecting to the Processing Center through regular telecommunication means in order to obtain the data needed to determine the coordinates of their location with an accuracy of few centimeters.

The project has a budget of 4,5 million Euros and is expected to be in full operation in 2007.

2.2 Digitization of Land Consolidation and Land Distribution Data

This project aims at the digitization and computerization of the data about land consolidation and land distribution projects that have been carried out by the Greek Ministry of Rural Development and Food (former Ministry of Agriculture). The computerized data will be used to speed-up and improve the cadastral survey procedures. The data about the performed land consolidations and land distributions, currently are in analogue form, and are depicted, in the majority of the cases, in 1:5.000 scale maps, or, in cases where there is a large degree of parcel segmentation or there are settlements in the area, in 1:1.000 to 1:2.000 scale maps. According to estimates, approximately 16.000 sq Kms of land have been subject to land consolidation or land distribution, something that accounts for approximately 40% of the agricultural land of the country or 12% of its total area.

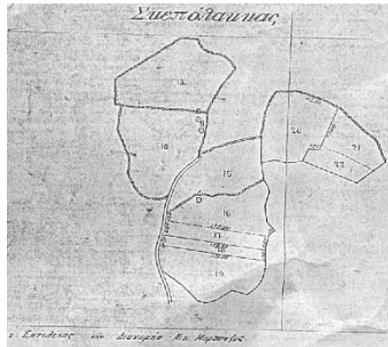


Figure 2.
Typical excerpt of a land distribution map that will be scanned and digitized in order to be used as evidence during the cadastral survey procedure.

The project has a budget of 1,9 million Euros and is expected to be completed in 2008.

2.3 Development of the digital database of the “active” titles in urban areas

This project aims at the development of a digital database that would store information contained in the deeds that have been registered in the Registries of the urban areas in Greece. Particularly, it will contain information about property rights that are still “active”, that is, they have not been nullified by land transactions that have taken place after the registration of the corresponding deeds. Operationally, in order to separate the registered deeds that contain “active” rights from those that do not, Ktimatologio S.A. will invite owners who have “active” rights on properties in urban areas to declare them and submit copies of the corresponding deeds. Contractors of Ktimatologio S.A. then, will process the submitted material and will create a GIS database that will contain the locations and the approximate boundaries of the properties, as well as, the legal information about the declared property rights. This database, at a later stage, will be used as a stepping-stone for continuing and completing the cadastral survey procedure. This project has a budget of 35 million Euros and it is expected to collect and computerize approximately 5.400.000 property rights in 107 urban areas in Greece.

2.4 Digitization and computerization of the Dodecanese Cadastre

This project aims at digitizing and computerizing the maps and documents that are maintained in the cadastral offices of the islands of Rhodes and Kos. Specifically, the cadastral maps, the cadastral books, the alphabetical and numeric indices, and the deeds that are archived in the above mentioned cadastral offices will be scanned and organized in a digital GIS database. Then, the digitized material will be used, as a stepping stone, in order to transform the cadastral system that operates locally in the island of Rhodes and Kos into a system that is compatible with the Hellenic National Cadastre. The project has a budget of 2,3 million Euros and will be completed in 2008.

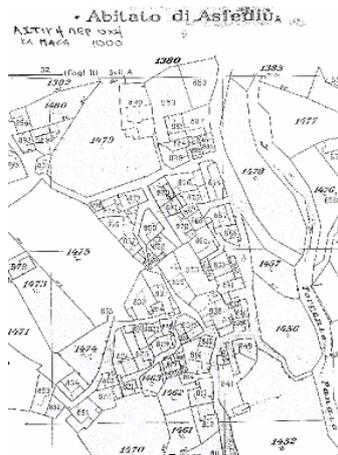


Figure 3.
 Typical cadastral map of an urban area in the island of Kos, Greece. Such diagrams will be scanned, digitized and georeferenced within the scope of the project: "Digitizing the Dodecanese Cadastre" in order to be used as evidence in a subsequent procedure of incorporating the Dodecanese Cadastre into the Hellenic National Cadastre.

2.5 Compilation of very-large-scale true ortho imagery for the urban areas

This project will produce very high resolution and accuracy, colored, digital ortho-imagery, as well as, a detailed Digital Terrain Model (DTM) for the urban areas of the country. The Ground Sampling Distance (GSD) of the imagery will be 20 cm. The imagery will be used to delineate the boundaries of properties in the urban areas during the cadastral survey procedure. The project has a budget of 3,2 million Euros and it will be completed by the year 2008.



Figure 4.
 Indicative example of a very-high resolution ortho-image of an urban area (in reduction).

2.6 Compilation of 1:5.000 Scale Orthophotomaps for the Entire Country

This project will produce 1:5.000 scale digital, colored, orthophotomaps for the entire country (132.000 sq Kms). The GSD of those orthophotomaps will be 50 cm. The maps will be used during the cadastral survey procedure primarily for the delineation of land parcels in rural and mountainous areas of Greece. The project has a budget of 6,3 million Euros and will be completed by 2008.



Figure 5.
Typical sample of a 50 cm GSD orthophotomap that will be produced for the whole country (in reduction).

2.7 Delineation of Forests and Forest Lands in Greece

This project has as a goal to produce a preliminary delineation of the forestlands in Greece, in order for the public authorities to carryout the legal validation of the delineated areas and be able, in the early stages of the cadastral survey procedure, to indicate the forest areas that are public property. This way, the ownership status of those areas will be clarified in time and the disputes during the cadastral survey procedure will be reduced.

The project has a budget of 8.3 million Euros and will be completed by the end of 2008.

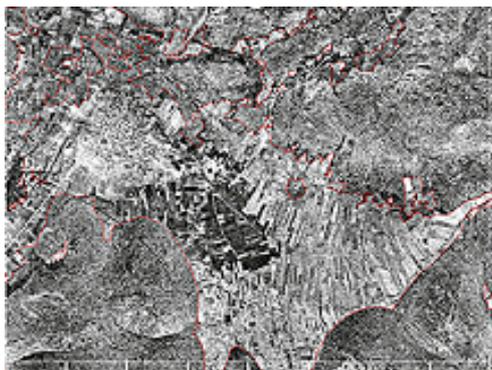


Figure 6.
Orthophotomap that shows the boundaries of forest areas (red line). Such areas, normally, belong to the State and are protected by legislation.

2.8 Production of Base Maps for Delineating the Greek Shore

This project aims at producing very high-resolution color-NIR orthophotomaps (25 cm GSD) and a detailed (1 m GSD) bare-earth DTM of a 300-meter wide zone along the coastline of Greece in order for it to be used for the delineation of the shore of the country. The same kind of information will be produced for similar strips along the banks of the “large lakes” and the “navigable rivers” of Greece. The land on the shore, as well as, the land along the banks of the “large lakes” and the “navigable rivers” is public and cannot be owned by individuals. However, due to its high value, such land often is subject of infringement by individuals. By producing this set of orthophotomaps and DTM and by providing it to the appropriate authorities of the State, it would be possible to delineate, well-in-advance, the shore along the coast and the banks of the “large lakes” and the “navigable rivers”. Thus, during the cadastral survey procedure, the appropriate authorities will know the shore and will be able to declare it as State property, reducing, therefore, the possibility of infringement.



Figure 7.
Typical sample of a high resolution color orthophotomap that will be used (in enlargement) for the delineation of the shore.

The budget of the project is 3,4 million Euros and the time horizon for its completion is the end of 2008.

2.9 Modernization of the IT Infrastructure of the Hellenic Cadastre

This project aims at developing the information technology (IT) infrastructure that would enable Ktimatologio S.A. to store and manage the cartographic and cadastral data, as well as, to provide high quality services to its users. Specifically, within the scope of the present project, Ktimatologio S.A. will establish a Data Center, a Disaster Recovery Center and the telecommunications infrastructure which will enable the peripheral cadastral offices, contractors, collaborators, and users to have a fast, secure, and reliable access to the cartographic and cadastral data. In addition, Ktimatologio S.A. will develop a Management Information System (MIS) in order to carryout effectively its operations.

The project has a budget of 10,3 million Euros and it will be completed by 2008.

2.10 Development of Web-services for the Dissemination of Data

This project intends to develop web-based applications that would enable users to access easily and effectively the digital cartographic and cadastral data that are available by Ktimatologio S.A. Such data include the 20 cm and 50 cm GSD digital color orthophotomaps that will be produced within the scope of the present Operational Plan, the very high resolution orthophotomaps of the coastal zone etc.

The project has a budget of 1,07 million Euros and it will be completed in 2008.

2.11 Development of Web-services for the Support of Future Cadastral Surveys

This project, similarly to the one mentioned above, aims at developing web-based services that would enable Ktimatologio S.A. to carry-out effectively future large scale cadastral surveys. Specifically, those services would enable individuals to obtain, through Internet, all forms required for declaring their properties during the cadastral survey procedures, submit

their declarations electronically, get information about the progress of the cadastral surveys, and obtain information about the outcome of any objections that they may have filled during the procedure. In addition, the contractors of Ktimatologio S.A., who would perform the data collection and processing during the cadastral survey procedures, would be able to up-load periodically the collected data and receive electronically guidelines and quality control directions. Finally, those services will support the work of the Objection Committees by allowing them to access relevant data.

The project has a budget of 3,4 million Euros and a completion horizon the 2008.

3. CURRENT STATUS OF THE PROJECTS

Currently (July 2006), the design of almost all the above-mentioned projects has been completed. Those projects will be outsourced to private sector firms, which will be responsible for the implementation. The outsourcing will be made through a series of international tenders. In fact, eight (8) of them have already been tendered, while two (2) others are on line for tendering.

In the near future, Ktimatologio S.A. will make an effort to finish the on-going tenders and sign contracts. Also, it is going to outsource the remaining projects so that their implementation would start as soon as possible. Most of those projects have a planned duration of approximately two (2) years and should be completed by the end of 2008.

4. DISCUSSION

Definitely, the Operational Plan that was presented here constitutes a significant departure from the corresponding plans that have been used in the past. However, its design and implementation has, so far, brought out several issues that worth noticing for future applications. First, the procedure for getting the necessary approvals for the plan from the Greek and the EU authorities was quite lengthy and bureaucratic. A substantial amount of effort and resources have been allocated to get it through the maze of rules and regulations both at the Greek State and EU levels. It must be noted that, despite the numerous checks, virtually very little has been added in the substance and the original design of the proposed projects. The design of the Operational Plan started in the Fall of 2003 and now, almost three (3) years later, the majority of the individual projects are still in the tendering stage. It is quite concerning the fact that projects, which have an implementation time of less than two (2) years, must go, under very smooth conditions, through a procedure of design, approval and contracting that lasts 3,5 years or more.

A second issue that worth mentioning about the Operational Plan is the reaction of the local professional societies. Upon its first public release in the beginning of 2004, the Operational Plan received a very negative criticism by almost all related professional associations (engineering, legal, forestry). Most of them discredit it and claimed that it was a useless Plan or even infeasible. However, after repeated explanations and debating, the initial concerns

have been removed and, currently, there is a consent that the Plan should go ahead. Definitely, the restructuring that was introduced by the Plan in the cadastral survey contracts has caused worries to the involved professionals because they must adjust the production operations of their firms.

The third issue was the reluctance of the involved State agencies to contribute towards the implementation of the Plan either by providing access to their archives or by giving the necessary data. Although this reluctance had been anticipated during the design phase of the Plan and despite the fact that several measures had been taken to handle it, yet, the whole issue has not been overcome completely and efforts must continue until all prerequisites are satisfied.

A final issue is the tenders. Almost all projects that have been tendered so far have had objections by tender participants. In fact, several of them ended up into the courts. In some instances, there have been appeals to court more than once for the same project. The competition among participants for better placement during the evaluation procedure is fierce and, no matter what Ktimatologio S.A. does, the delays seem to be unavoidable.

All the above indicate that the legislative, organizational and societal obstacles are, normally, more difficult to overcome than technological and methodological ones. This observation, of course, is neither new nor unique. It has been encountered in other settings and situations worldwide and the Greek case simply verifies them. However, despite the above-mentioned issues, which have a rather negative connotation, the proposed Operational Plan has had already some ground breaking implications. For example, the development of HEPOS has caused the initiation of the process to redefine the Hellenic Geodetic Reference System, which is already 20 years old and needs adjustment. The intention to produce the orthophotomaps and DTM of the coastal zone has prompted the Ministry of Finance and Economics, which is responsible for the management of the shore, to redraft the related legislation in order to account for the new method suggested by the Plan. It must be noted that so far, using traditional field methods, only 10% of the Greek shore has been legally delineated during the past 65 years. All these, verify the assertions made in the literature (e.g. De Sotto 2000) that the introduction of a new cadastral system in a country causes multiple and far reaching effects and contributes substantially towards the transformation of its norms.

5. CONCLUSIONS

In this paper we have described the Operational Plan “Data and IT infrastructure for a modern cadastre” which has been designed by the Greek and EU authorities to facilitate the development of the Hellenic Cadastre. This Plan adopts a different approach towards developing a cadastral system than the plans that have been used in the past. Specifically, the Plan, instead of setting-up projects in a “vertical” fashion, where all activities required by the cadastral procedure are performed sequentially by the same contractor at a local level, focuses, first, on establishing the necessary geodetic, data, and IT infrastructure at a nation-wide level and, then, on carrying-out the local level tasks of the cadastral survey procedure.

This way, the benefits that result from specialization, synergies among projects, and economies of scale can be realized, while the risks and uncertainties that, normally, are encountered during the implementation of large-scale cadastral survey projects can be avoided. The future will indicate whether this new approach would fulfill expectations and produce the anticipated results. Nevertheless, the availability of a state of the art geodetic, data, and IT infrastructure, which would be established within the scope of this Operational Plan, comprises a valuable resource not only for the Hellenic Cadastre but for Greece as a whole, since this infrastructure can be used to support numerous economic and social activities in the country. Moreover, the availability of the infrastructure, offers new challenges and opportunities for further re-engineering of the Hellenic Cadastre project and for identifying better and more innovative ways of developing and operating a modern cadastral system.

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BIOGRAPHICAL NOTES

Dr. Lolonis is the Head of the Project Planning Office of Ktimatologio S.A. (Hellenic Cadastre). He has a diploma in Rural and Surveying Engineering from the National Technical University of Athens, Greece (1986), a Master of Arts in Geography from the University of Iowa, U.S.A. (1990), and a Ph.D. in the same field from the same institution (1994). Dr. Lolonis specializes in cadastre, Geographic Information Systems (GIS), cartography, and spatial analysis. In the past, he has worked extensively in the areas of spatial decision support systems, spatial statistics, spatio-temporal database design, and spatial database accuracy. He has authored (or coauthored) more than 15 research articles in international journals and conference proceedings (e.g. *Cartography and GIS*, *Computers, Environment and Urban Systems*, *Statistics in Medicine*, *GIS/LIS*, *FIG*). For his academic performance and work, Dr. Lolonis has received several awards by Greek and international organizations, such as the Hellenic Institute of Governmental Scholarships, The National Technical University of Athens, The University of Iowa, The Association of American Geographers, and the Iowa Department of Public Health. He is a member of the Technical Chamber of Greece, the Hellenic Association of Rural and Surveying Engineers, the Hellenic Society of Photogrammetry (member of the Auditing Committee since 2003), the Hellenic Association of Computer and Information Technology Scientists, and the Hellenic Geographic Information Systems Society (founding member). For the past ten (10) years, Dr. Lolonis has been working for the Hellenic Cadastre on various technical and managerial topics, such as technical specifications, tenders, R&D, project monitoring, and corporate planning.

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