Exploring the Cost Effectiveness of Services in Academic Libraries: A Case Study with the Use of Time-Driven Activity-Based Costing

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Over the past decade, the financial crisis has led to reduced government funding for academic libraries in Greece. Now more than ever, it is imperative for library managers to improve their knowledge and understanding of cost behavior, in order to effectively deliver high quality services at decreasing costs. To do so, they need to apply clearly-defined costing methods, such as Time-Driven Activity-Based Costing (TDABC), that allow them to identify the various costs involved in the library processes. In our study, we applied the TDABC method at the medium-sized library of the University of Macedonia (UoM), in Thessaloniki, Greece, to evaluate the costs of the Inter-library Loans (ILL) services. Since the library managers did not adopt a cost allocation method, the cost estimation of the UoM ILL services was rather simplistic and rudimentary. Our research provides empirical evidence of the advantages of TDABC in an academic library setting. Namely, the TDABC method can help library administrators decide how to successfully allocate the available resources and improve the efficiency of the library processes.

Introduction

The global economic crisis has affected the academic libraries in Europe and the USA.[1] Due to limited state funding and an increasing cost of information, academic library managers need to apply effective costing methods to improve the allocation of library resources and offer high quality services at diminishing costs.[2] They need to use reliable management techniques based on effective information regarding cost assessments and library processes.[3]

Many studies have applied cost analysis for university library services using contemporary costing methodologies such as Activity-Based Costing (ABC) or Time-Driven Activity-Based Costing (TDABC).[4] ABC is a useful management tool for academic library managers, because it informs them about the costs of services and cost drivers. The ABC system was introduced

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by Cooper and Kaplan in the mid-1980s as an alternative costing system and was first applied to manufacturing companies. According to the ABC system, the cost of resources is allocated to activities using cost guides (i.e. number of book orders, number of loans between libraries, number of machine hours, etc.), and the cost of activities is allocated to cost objects based on the relevant cost guides.[5]

Although the ABC system can be a sufficient costing method, there are several limitations. Firstly, ABC can take a long time to implement due to the complexity of the activities. Secondly, ABC includes only one cost driver per activity. In reality, there is more than one cost driver per activity. Thirdly, library managers need to update the results regularly, which makes ABC implementation more costly.[6]

In 2003, Kaplan and Anderson introduced TDABC as a time-driven, improved version of the ABC method that would overcome the difficulties of implementing and constantly updating the ABC system. TDABC is faster to update and uses time as the only cost driver. TDABC is considered an easy-to-implement method since it only estimates for each activity two simple parameters: 1) The cost/time unit of the resource (i.e., personnel, library management system) and 2) the time units (usually estimated in minutes) required to perform an activity by the resource.[7]

TDABC method is considered a management accounting innovation that allows managers with no experience in accounting science to perform cost analysis activities efficiently.[8] In fact, many researchers consider TDABC to be a simple, easy-to-learn and easy-to-apply costing system for libraries. However, there are only a few studies that evaluate whether the technique of TDABC is effective for the most important library services like lending, cataloguing, acquisition, and the interlibrary loan (ILL) services.[9]

The aim of our study is to evaluate the application of the TDABC method to the academic library of the University of Macedonia (UoM), Thessaloniki, Greece, to estimate the costs of ILL services.

The UoM serves approximately 9,120 undergraduate students and offers eight undergraduate and 39 master's and doctoral degrees. According to the Carnegie classification of institutions of higher education, the university is considered a middle-sized university and is representative of the Greek Universities since most of them (i.e., 43–45%) are also middle-sized.[10] The UoM library may also be considered a representative case study for the Greek academic libraries since the procedures and policies applied in the Greek academic libraries are almost the same.

Although TDABC could improve the cost management of many library processes, we have focused our research/analysis on the inter-library loan services. As the number of interlibrary loans has increased in recent years, ILL is considered a popular service among academic libraries.[11] However, the existing cost analysis of ILL often either overestimates or underestimates the costs associated with these services. Although the cost of simple and complicated ILL requests vary significantly, most studies divide ILL cost by the number of ILL transactions (requests).[12] Hence, allocating the same cost to different type of requests produces inaccurate cost estimates.[13]

The results of our in-depth TDABC cost analysis may help library managers better understand the origin of ILL services' costs. The UoM library managers cannot allocate cost for each library service, so they have to accept inaccurate and rough cost estimations. Moreover, the detailed TDABC results with costs, time, and resources for each activity will help them

optimize processes and understand which activities need to be improved or discarded. The results of our study will help library administrators make optimal decisions for the efficient allocation of library resources.

The remainder of this paper is structured as follows: in the literature review section, we present the TDABC technique. In the methods and results section, we describe the TDABC implementation steps for the ILL process at the UoM library. Finally, in the two last sections we discuss the findings of our study and the implications and contribution for library practice.

Literature Review

Academic libraries must provide high quality and cost-effective services. The cost effectiveness of the library services must be assessed with efficient cost analysis methods. However, the total cost of the library services is usually estimated by traditional costing systems rather simplistically, as the sum of direct costs (i.e., material and labor) and indirect costs (i.e., a percentage of overheads).

Conventional costing systems are considered cost-efficient if indirect costs are low and the range of services is limited. Nowadays, the indirect costs have become more significant compared to the direct costs, especially in organizations with a wide range of services such as libraries.[14] As a result, the traditional costing systems cannot provide accurate cost information to library managers.

Activity-based costing (ABC) is an alternative costing technique that aims to correct the restrictions of traditional methods by evaluating the cost of the activities for each process.[15] Thus, ABC helps determine which activities are significant or expensive.[16] However, ABC is primarily based on subjective information. The preferred method of data collection is through interviews, in which the organisation's employees state the percentage of time they spend on different activities of each process.[17] Another disadvantage of the ABC system is that it needs to be updated very often to reflect current practice, which further increases its operating cost.[18]

To overcome the difficulties of implementing and constantly updating the ABC system, Kaplan and Anderson introduced TDABC as an improved version of the ABC method.[19] TDABC records analytical information for each activity, such as duration, frequency, and the staff who carried out each activity. The TDABC method provides detailed cost data through process maps, which essentially outline a sequence of activities.[20] The time to perform each activity is measured via direct observation.

TDABC uses a simple time equation to estimate the duration of the process, which is calculated as the sum of the time of the activities in the process. The time equation can evaluate all the possible scenarios for each process (i.e., different combination of activities). The costs are assigned to the cost object by multiplying the cost per time unit of the resource by the time required to perform the activities.[21] The TDABC method provides significant information on inefficient activities, that may need to be eliminated to reduce costs. For example, the application of TDABC to a multinational distributor of scientific products helped them transform 1,200 activities to just 200 department processes.[22]

TDABC was applied in various business fields such as manufacturing, banks, hospitality, healthcare, and nonprofit organizations such as libraries. Everaert et al. used the TDABC method to evaluate the cost of the logistic processes of a wholesaler company in Belgium. While the application of the ABC method ignored the complexity of operations and misallocated 55 percent of all costs, TDABC provided a detailed cost analysis. Thus, the company managers

could evaluate more accurately the profitability for each customer. This new information helped them improve the company's profitability by introducing new discount policies and renegotiating contracts with customers and suppliers.[23] Keel et al. reviewed the empirical application of TDABC to the health care sector. TDABC can evaluate efficiently and accurately the cost of the complex processes and achieve operational improvement. Thus, it should be gradually incorporated into functional systems to control the cost and create value in health care.[24]

Given its simplicity and efficiency, many researchers have chosen to apply the TDABC method to evaluate one or more services at academic libraries. Stouthuysen et al. applied TDABC in order to reduce the cost of activities connected with the acquisition process in a university library in Belgium.[25] Kont focused her analysis on the same process at two Estonian university libraries,[26] while Sigüenza-Guzmán et al. presented the use of TDABC for a library cataloguing process at a Belgian library.[27] They have also used TDABC to analyze lending and returning processes at the Katholieke Universiteit Leuven (KU Leuven). Kissa et al. have applied the TDABC method to the lending processes at the UoM library, Greece.[28] All of the above researchers conclude that the TDABC method seems to be a cost management technique that provides credible cost information for the most important library services.

For many years, ILL has been considered a very important process for an academic library as, "*it is generally used to fill the gap between academic libraries collections and what their patrons actually need*."[29] The first major cost study for ILL services, was conducted during 1974 from Vernon Palmour et al. for the association of Research Libraries (ARL). While the volume of ILL transactions more than doubled in the previous five years, the academic libraries did not equally share the costs. The researchers surveyed 189 academic libraries and examined various ways to finance interlibrary loans. They recommended the use of coupons sold by a central clearing house.[30]

ILL is still a popular service among academic libraries. Lars Leon and Nancy Kress researched twenty-three medium-to-large academic libraries in the United States. They evaluated the cost of resource-sharing services, such as ILL borrowing and lending copies and loans. They concluded that the largest cost is staff cost.[31] Recently, the Online Computer Library Center (OCLC) introduced a free internet-based tool (i.e., OCLC Interlibrary Loan Cost Calculator) that may be used as a real-time ILL cost calculator in order to help library administrators and practitioners better understand the costs associated with sharing collections.[32]

However, very few researchers have used the TDABC method to evaluate ILL service at an academic library.[33] Moreover, the estimated ILL cost is actually difficult to compare.[34] Marc-André Simard et al. reviewed ILL cost studies from 1997 through 2017.[35] They found that, due to methodology problems, the ILL cost per transaction varied significantly from $3.75 up to $100.00. For example, some researchers counted only the filled ILL requests, while others counted both filled and unfilled ILL requests. However, Jackson's estimation of ILL cost at $17.50 remains the guideline for most researchers and librarians because she examines ILL with methodological rigor.[36]

In 2007, Pernot et al. provided a whole new approach based on TDABC by calculating the cost data for every activity of the ILL processes.[37] This in-depth TDABC analysis was implemented at the ILL services of the Arenberg Library of the Katholieke Universiteit Leuven (KU Leuven) in Belgium. According to the results of that study, TDABC could decrease the cost management of the library services given that it breaks down the cost per transaction. Thus, TDABC can improve the library processes by estimating the activities which are costly

and with no added value. However, no further research has been conducted based on ILL's TDABC cost analysis.

Methods and Results

The aim of our research is to evaluate the implementation of TDABC at an academic library. In particular, we have implemented the TDABC method to estimate the cost of the ILL service. Since it is not feasible for the library to buy everything its patrons request, ILL is considered one of the most important and difficult library services. This service provides patrons with quick access to information whenever they need it.[38] As a result, accurate cost estimation is important because the operating costs of this service are high, and the requests are very time-consuming to process. Furthermore, ILL is a service which requires experienced staff with high linguistic and digital skills.

The academic library studied was the UoM library, Thessaloniki, Greece. The UoM library is operated by approximately 20 full-time-equivalent employees (FTE). The number of registered users is estimated to be about 8,270 per academic year. In order to provide ILL services efficiently, the UoM library is a member of the Hellenic Interlibrary Loan Network (HILL-net) and the ILL Service of Scientific and Technological Libraries National Network. This cooperation with other Greek libraries is an effective way to overcome budgetary constraints.[39] The UoM library also cooperates with the Document Supply Service of the British Library (BLDSS) and a cooperative German document delivery service called Subito. The aforementioned partnerships reduce Library Management System (LMS) costs (i.e., hardware, software and networking) and accounting costs (i.e., clearance, accounting and payments).

However, there is no accurate and detailed cost analysis for each library service.[40] All the library costs are processed in the central accounting system of the University of Macedonia through the budget-reporting system. There is also no cost allocation for individual library services, such as ILL. Moreover, all ILL cases are estimated at the same cost, without taking into account different types of ILL requests or different types of providers.

We implemented TDABC method combining qualitative and quantitative methods to ensure the reliability of our results. Our mixed method analysis may increase the rigor and enrich the findings of our research.

In the next paragraphs we thoroughly explain the six-step application of TDABC at the UoM library.[41] According to our analysis of the UoM ILL service, we have identified four different ILL processes. Each ILL process is a sequence of activities and may have several scenarios or cases. Each activity is described with a letter abbreviation (i.e., a, b, c …k). In detail:

Step 1: Identify the most important ILL processes

We have thoroughly studied the UoM library guide, which describes the library processes. We then interviewed the UoM ILL staff and the UoM library manager using open questions. The ILL processes were identified by separating outgoing and incoming requests. In particular, the UoM library borrows items that are not available in its collections from other libraries (outgoing requests), or lends items from its collections to other libraries or patrons (incoming requests). If the ILL requests are for books, they are entered to the Institutional Research Information System (IRIS) ILL system. If the ILL requests are for journal articles, they are entered to the ILL system of the National Documentation Center (NDC). As a result, we have identified the main activities for each ILL process and the task that each staff member undertakes in these processes.

We have identified four main ILL processes, which include various activities and sub-activities. These processes are: 1) Incoming requests for books, 2) Incoming requests for articles, 3) Outgoing requests for books and 4) Outgoing requests for articles.

Step 2: Estimate the total cost of each resource group

The cost data were based on real data provided by the financial and human resources manager. We also derived cost data from various UoM library reports. All the financial data like labor costs, library management system costs, and overhead costs were collected for the year 2018.

According to the annual UoM accounting reports, the total annual cost of library services includes both direct and indirect costs.

The direct costs are:

- Labor costs: The personnel assigned to the above processes represent 1.5 full-time employees (FTE). The total monthly cost is about € 2,026 and the total yearly cost is about € 24,312*1.5= € 36,468
- Library management system costs, which include hardware (e.g., Radio-frequency identification [RFID] technology) and software (e.g., specialized software for ILL services) costs. The yearly cost is approximately € 7,220

The indirect costs are:

- Staff overhead costs (e.g., management, accounting, cleaning, utilities, stationery material). It is approximately € 85,083
- Library management system overhead costs (e.g., leasing photocopier, depreciation of equipment [e.g. electronic, furniture]). It is approximately € 21,805

Step 3: Estimate the time of each resource group (practical capacity time)

Practical capacity is specified without the assessment of idle time, which may be: maintenance, vacation, illness, education and meetings, or other.[42] We have estimated the practical capacity of each resource group at 80% of theoretical time capacity for people, and at 85% for machines (excluding maintenance and repair time).[43] This approach was selected to simplify the cost calculations of our study.

According to the Greek labor legislation, staff must work forty hours per week (theoretical capacity). We have calculated the practical capacity as follows:

> 80% × 40 hours/week × 52 weeks/year × 60 min/hour = 80% × 124,800 min = **99,840 min/year.**

According to step 2, there are 1.5 full-time equivalent (FTE) for the ILL processes, thus the practical capacity time for staff is 99,840 min/year * 1.5 = **149,760** min/year. The 1.5 FTE is related to the work of three employees. The first employee responsible for the ILL service is working 100 percent of her/his time, while the second and third are working 30 percent and 20 percent of their time respectively. The UoM library is open to the public from 8:00 a.m. to 8:00 p.m. for weekdays, and from 8:30 a.m. to 3:00 p.m. for Saturdays. This time accounts in total for 66.5 hours per week and represents the theoretical time capacity for LMS. Thus, the practical capacity for LMS is = 66.5 hours × 85% ×52 weeks/year ×60 min/hour =**176,358** min/year.

Step 4: Calculate the unit cost of each resource group

The cost per time unit (1) is equal to the total cost of the resource (step 2) divided by the practical capacity (step 3) [44]:

Cost per time unit = total cost of the resource/practical capacity (1)

The staff and LMS costs include the staff and LMS overhead costs respectively. The resulting costs are presented in table 1.

TABLE 1
Unit Cost Per Resource Group

Resource group	Calculations	Cost Per Minute (€/min)
Staff labor costs	(36,468/149,760) + (85,083/149,760) = 0.24 + 0.56	**0.80**
LMS	(7,220/176,358) + (21,805/176,358) = 0.041 + 0.124	**0.16**

The highest cost is the staff labor cost (0.80 €/ min). As shown in step 2, that is because of the high direct staff and staff overhead costs (36,468 € and 85,083 € respectively).

Steps 5 and 6: Estimate the total time (step 5) and the cost/activity (€) and total cost (step 6) for all the different cases of each ILL process

In the last two steps, we have modeled the workflow of each ILL process using Business Process Modeling Notation (BPMN) and estimated the total time and cost for each process. The ILL processes are: ILL incoming requests for 1) books (figure 1) or 2) articles (figure 2), and ILL outgoing requests for: 3) books (figure 3) or 4) articles (figure 4).

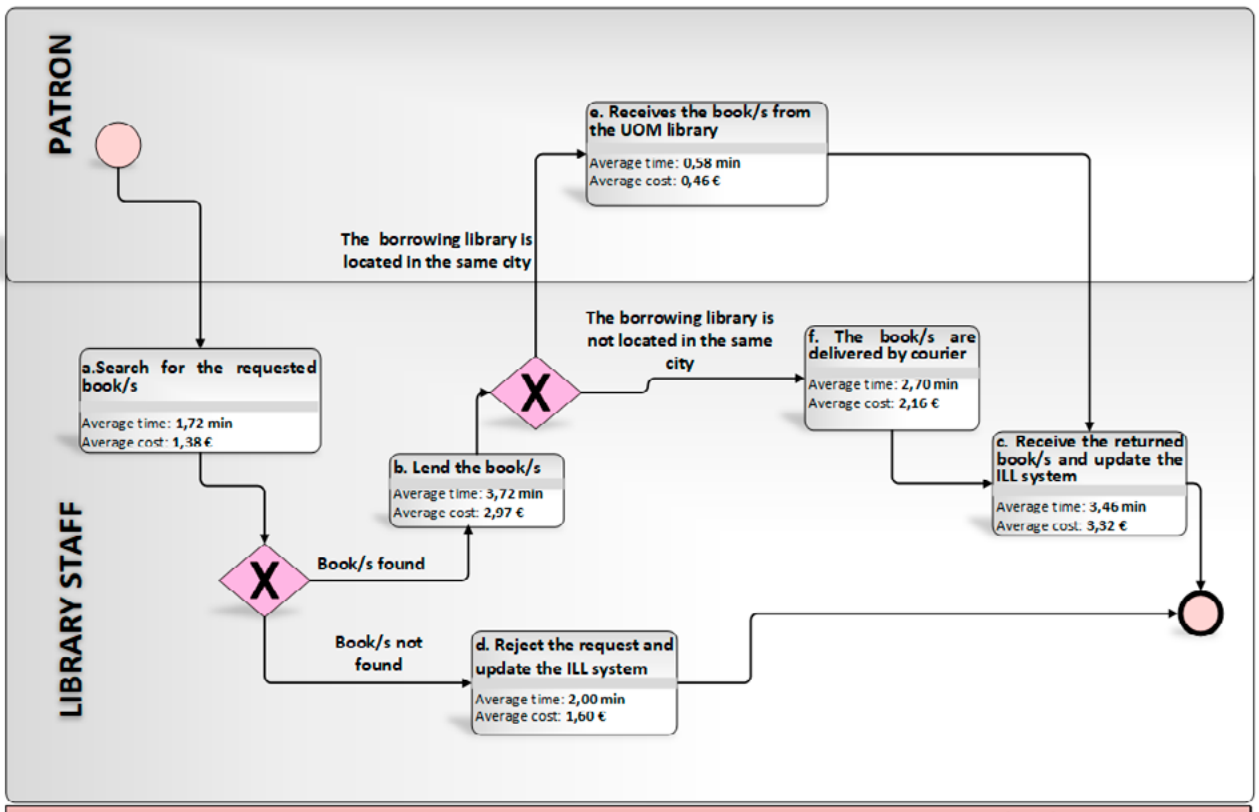
In step 5 we calculated the time required to complete one unit of an activity for each one of the four main ILL processes. The time data was gathered via direct observation with the excellent cooperation and contribution of the ILL staff. We carried out the data collection using a stopwatch. The data collection lasted for the whole academic year 2018–2019 (October 2018–September 2019) to cover all the different cases of ILL requests at the UoM library. To avoid bias, we validated the results by repeating the data collection several times for all cases. The total number of observations was large (140). We have estimated the average time for each activity to facilitate time calculations.[45]

In step 6 we estimated the cost for each process. We estimated the cost/activity (€) and total cost for all the cases of each ILL process by multiplying the unit cost of each resource group (step 4) by the time required to perform the activity (step 5).[46] We created four cost tables (tables 2–5) (Appendix A) to calculate the cost for each one of the four main ILL processes mentioned in step 1. In particular, table 2 and table 3 (Appendix A) estimate the explicit costs for the incoming requests of books and articles respectively, while table 4 and table 5 (Appendix A) estimate the costs for the outgoing requests of books and articles accordingly. We calculated and presented separately the cost of the standard and optional activities for each process. At the end of each cost table (Appendix A), we calculated the cost of all the possible cases (i.e., case A, case B, case C, etc.) for each ILL process. For simplicity's sake, in the detailed analysis of each process that follows and in the tables in Appendix A, requests are treated as requests for a single item, with the understanding that requests may be made for multiple items at the same time. Requests for multiple items would, understandably, take more time.

In detail:

I. *Incoming requests for books (figure 1)*

FIGURE 1
Incoming Requests for Books



CASE	TASKS	DESCRIPTION	TOTAL TIME (min)	TOTAL COST (€)
A	a, b, e, c	The borrowing library is located in the same city	9,48	8,13
B	a, b, f, c	The borrowing library is not located in the same city	11,6	9,83
C	a, d	The UOM library does not possess the requested book/s	3,72	2,98

The UoM library staff check the IRIS system daily for new requests. When they receive a new request, they search for the requested book (activity **a** time: 1.72 min). If the UoM library does not possess the requested item, the ILL staff respond negatively through the IRIS system to the library that requested the book (activity d time: 2 min). If they find the book, they enter the request to the KOHA (Open source library automation software) and IRIS lending management systems (activity **b** time: 3.72 min). Then, they deliver the book in one of two ways: **1)** if the borrowing library is located in the same city (i.e., Thessaloniki), the book is delivered from the UoM library (activity **e** time: 0.58 min), or **2)** if the borrowing library is located outside the city, the book is delivered by a courier service (activity **f** time: 2.70 min).

After the successful delivery of the book, the UoM library staff close the request. If the collaborating library is located in the same city, the patron returns the material to the UoM library with no charge. If the material is returned by a courier service, the patron has to pay for the courier costs. The UoM library staff receive the book and return it to the shelf. They also update the KOHA and IRIS systems about the completion of the ILL process (activity **c** time: 3.46 min).

The resulting equation in minutes for the total time of incoming requests is as follows:

SUM1= a + b + c + [(**e** {if the borrowing library is in the same city} +**d** {if the requested item is not available} + **f** {if the borrowing library is located outside the city}]

There are three cases related to the incoming requests for books:

Case A: If the borrowing library is located in the same city:

***SUM1 of case A* = a + b + e + c** = 1.72+3.72 + 0.58 + 3.46 = **9.48 min**

Case B: If the borrowing library is not located in the same city:

SUM1 of case B = **a + b + c + f** = 1.72+3.72 + 3.46 + 2.70 = **11.6 min**

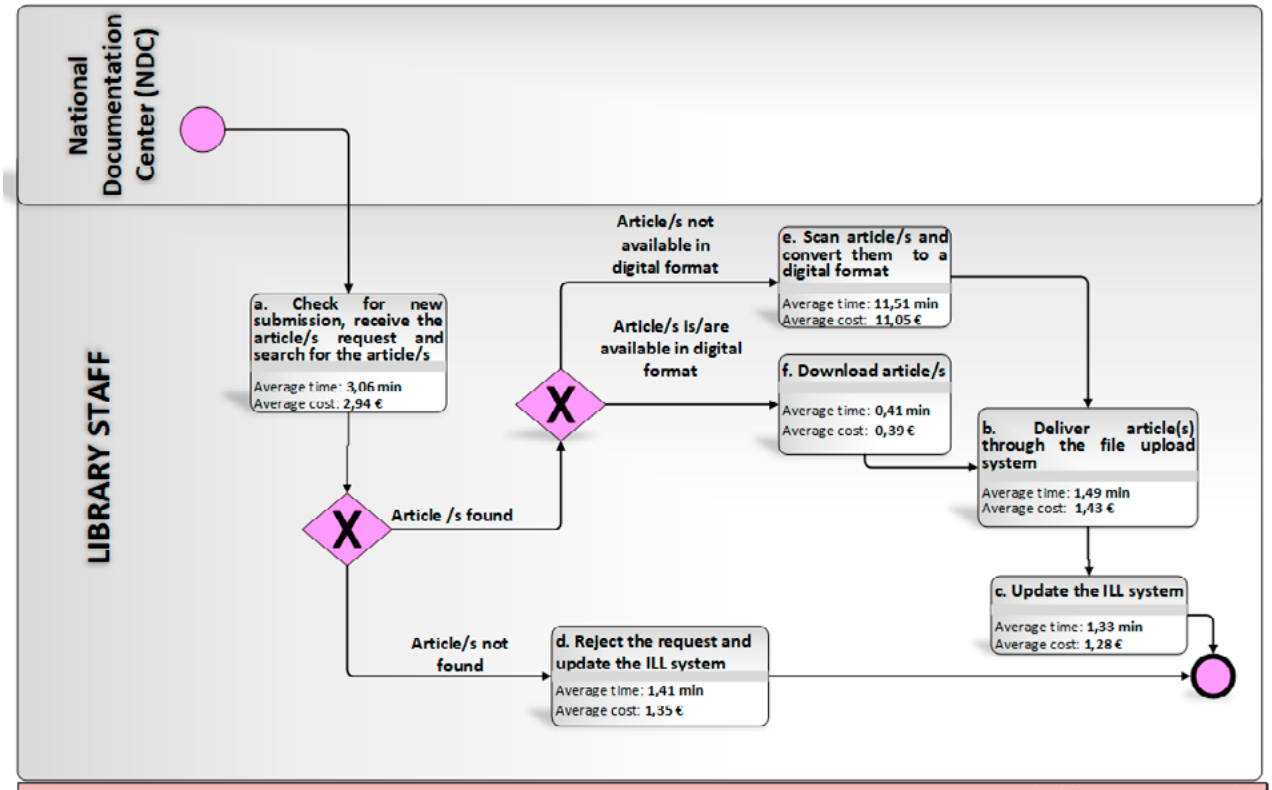
Case C: If the library of the University of Macedonia does not possess the requested item:

SUM1 of case C = **a +d** = 1.72+2= **3.72 min**

The cost of the ILL process for the incoming requests for books depends on the location of the cooperating library (table 2). If the borrowing library is located in the same city, the ILL process cost is 20.9% less compared to the cost when the borrowing library is located in another city. According to our results, the two standard activities of lending (a) and returning (b) the books are the most costly. The cost of these activities is €2.97 and €3.32 respectively.

II. *Incoming requests for articles (figure 2)*

FIGURE 2
Incoming Requests for Articles



CASE	TASKS	DESCRIPTION	TOTAL TIME (min)	TOTAL COST (€)
A	a, e, b, c	The article/s is/are available in hard copy	17,39	16,70
B	a, f, b, c	The article/s is/are available in digital format	6,29	6,04
C	a, d	The UOM library does not possess the requested article/s	4,47	4,29

The UoM library staff receive a lending request by email from the ILL system of the NDC. They search for the requested article in the library collections (activity **a** time: 3.06 min). If they cannot find it, they record the request and inform the ILL NDC system (activity **d** time: 1.41 min).

If they find the article as a hardcopy, they must copy, scan, and convert it to a digital format (activity **e** time: 11.51 min). If they find the article in a digital format, they just download it (activity **f** time: 0.41).

They then deliver the requested article through the library file upload service (https://fs.lib.UoM.gr/) (activity **b** time: 1.49 min).

After the successful delivery of the article, the UoM library staff close the request in the ILL NDC system (activity **c** time: 1.33 min). The article remains in the possession of the collaborating libraries.

The resulting equation in minutes for the total time of incoming requests for an article is as follows:

SUM1 = a + **b** + **c** + [**e** {if article in hardcopy} + **d** {if the requested item, is not available} + **f** {if article in digital format}]

There are three different cases concerning the incoming requests for articles:

Case A: Incoming request for article, if the article is available in hard copy:

***SUM1 of case A* = a + b + c + e =** 3.06+1.49 +1.33 + 11.51 = **17.39 min**

Case B: Incoming request for article, if the article is available in digital format:

***SUM1 of case B* = a + b + c + f =** 3.06+1.49 + 1.33 + 0.41 = **6.29 min**

Case C: Incoming requests for article, if the UoM library does not possess the requested item:

***SUM1 of case C* = a +d =** 3.06 + 1. 41 = **4.47 min**

The most expensive activity of the incoming requests for articles (table 3) is when the UoM library staff have to convert the hardcopy article to a digital format (Case A cost = €16.70). The TDABC analysis shows that the cost of the case A is about 64% higher, compared to the case (Case B) where the article is available on a digital format (€6.04). The activity's cost is high (Activity e), because the time consumed to scan the article and convert it to a digital format is also high (11.51 min).

If the UoM library does not have the article, the staff respond negatively to the requesting library. In that case, the process cost is €4.29.

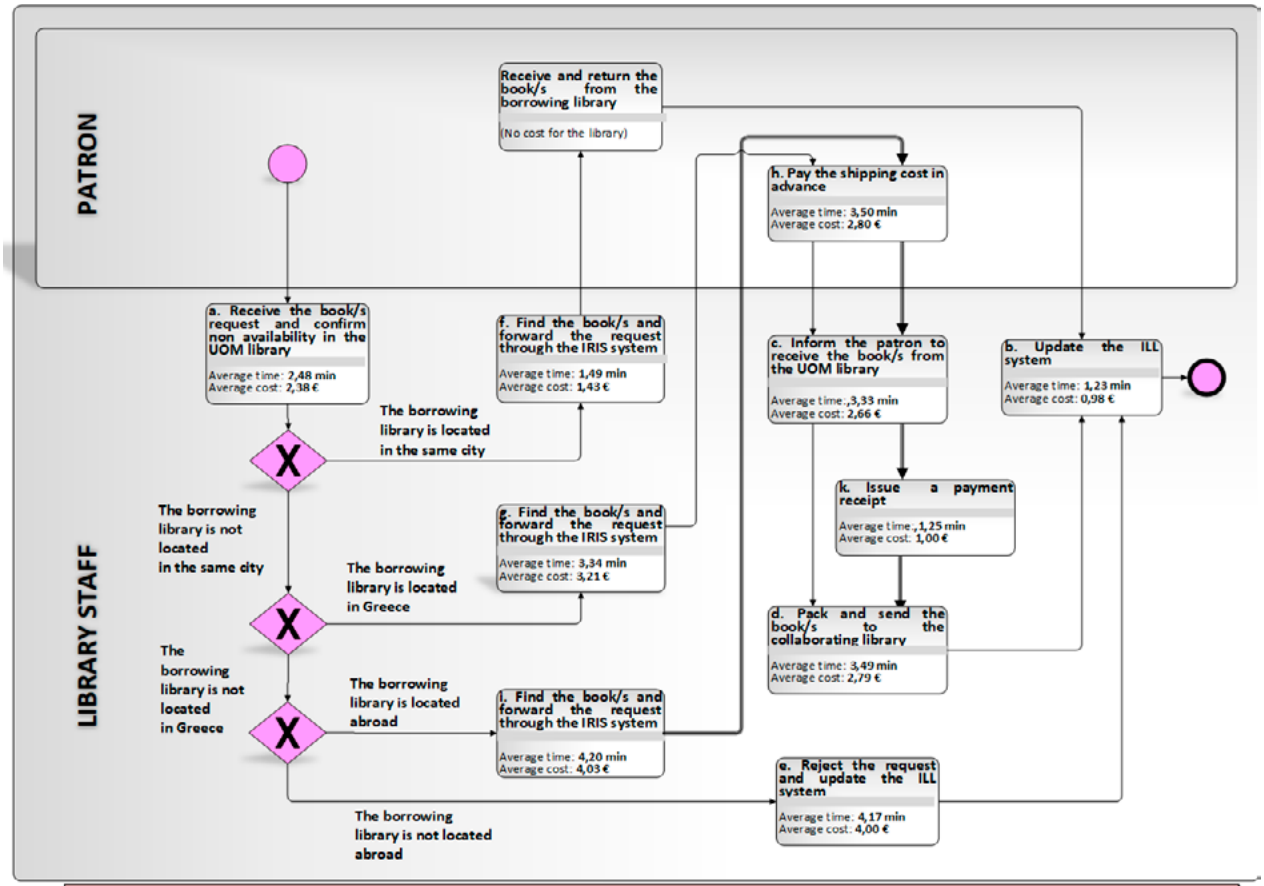
III. *Outgoing requests for books (figure 3)*

The patron checks the UoM Library's catalog to verify that the requested item is not included in the UoM library collections. Then, a request is completed in the ILL IRIS system.

The UoM library staff check the IRIS system daily for new outgoing requests. If they find a new request, they first search and confirm that the book is not available in the UoM library collections, and that if it is available, it is not freely available online (activity **a** time: 2.48 min).

Subsequently, the UoM library staff search for the requested book in the collections of the cooperating libraries that are located in the same city (i.e., Thessaloniki). If they find the requested book, they forward the request to the cooperating libraries (activity **f** time: 1.49 min).

FIGURE 3
Outgoing Requests for Books



CASE	TASKS	DESCRIPTION	TOTAL TIME (min)	TOTAL COST (€)
A	a, f, b	The book/s is/are located in the collections of the same city	5,20	4,79
B	a, g, h, c, d, b	The book/s is/are located in the collection of a Greek library not located in the same city	17,37	14,82
C	a, i, h, c, k, d, b	The book/s is/are located in a foreign library	19,48	16,64

If they do not find the book, they check the collections of other cooperating Greek libraries through the collective catalog of Greek academic libraries library systems. If they find it in a Greek library which is not located in Thessaloniki, they forward the request to the cooperating library through the IRIS system (activity **g** time: 3.34 min). The patron must pay the fee and the shipping costs in advance and in-person (activity **h** time: 3.5 min). According to the UoM library rules, the patron cannot pay in another way, such as e-banking.

If the UoM library staff do not locate the book in a Greek library, they check the collections from a foreign library using the BLDSS and Subito systems.

If they find it, they ask the patron to pay the expenses in advance. If the patron agrees, staff member forwards the request via BLDSS and Subito and updates the IRIS system (activity **i** time: 4.2 min). If the cooperating library responds negatively, the UoM ILL staff mark the request as unavailable and update the IRIS system (activity **e** time: 4.17 min).

At the end of the process, the UoM library staff issue a payment receipt and deliver the requested book to the patron. If the item is handled by the cooperating library in the same city, the patron receives a message to collect the book from the cooperating library.

If the item is handled by a cooperating Greek library outside of the city, the UoM library staff can expect to receive the book by courier (estimated delivery time: 1 to 3 days). If the

request is handled from a foreign library, the staff checks the order status through the BLDSS and Subito systems and waits for the arrival of the requested book (estimated delivery time: 1 to 3 weeks). When the library staff receive the requested book, they issue a payment receipt for the ILL fee (activity **k** time: 1.25 min). In these two last cases, the staff also issue an invoice through IRIS and notify the patron to pick up the book from the UoM library (activity **c** time: 3.33 min).

Finally, the patron returns the book to the UoM library. In case of delay, the UoM library staff is informed via IRIS and reminds the patron to return the book on time (activity **j** time: 1.2 min). When staff receives the book, they pack it and return it to the collaborating library (activity **d** time: 3.49 min). After the completion of the ILL process, the library staff update the IRIS system (activity **b** time: 1.23 min).

The resulting equation in minutes for the total time of outgoing requests for a book is as follows:

SUM1 = **a** + **b** + [**f** + {if the book is located in the collections of a cooperating library which is located in the same city} + **g** {if the book is located in the collections of a Greek library which is not located in the same city} + **i** + **k** { if the book is located abroad} + **e** { If the requested item isn't available}+ **c** + **d** + **h**{ if the book is located in the collections of a Greek library which is not located in the same city and abroad}+ **j** {if the patron delays the return of the book}]

There are three cases related to the outgoing requests for books:

Case A: if the book is located in the collections of a cooperating library which is located in the same city:

***SUM1 of case A*= a + b + f =** 2.48 + 1.23 + 1.49 = **5.20 min**

Case B: if the book is located in the collections of a Greek library which is not located in the same city:

***SUM1 of case B*= a + b + c + d + g + h =** 2.48 + 3.33 + 3.49 + 1.23 + 3.34 + 3.5 = **17.37 min**

Case C: if the book is located in the collections of a foreign library:

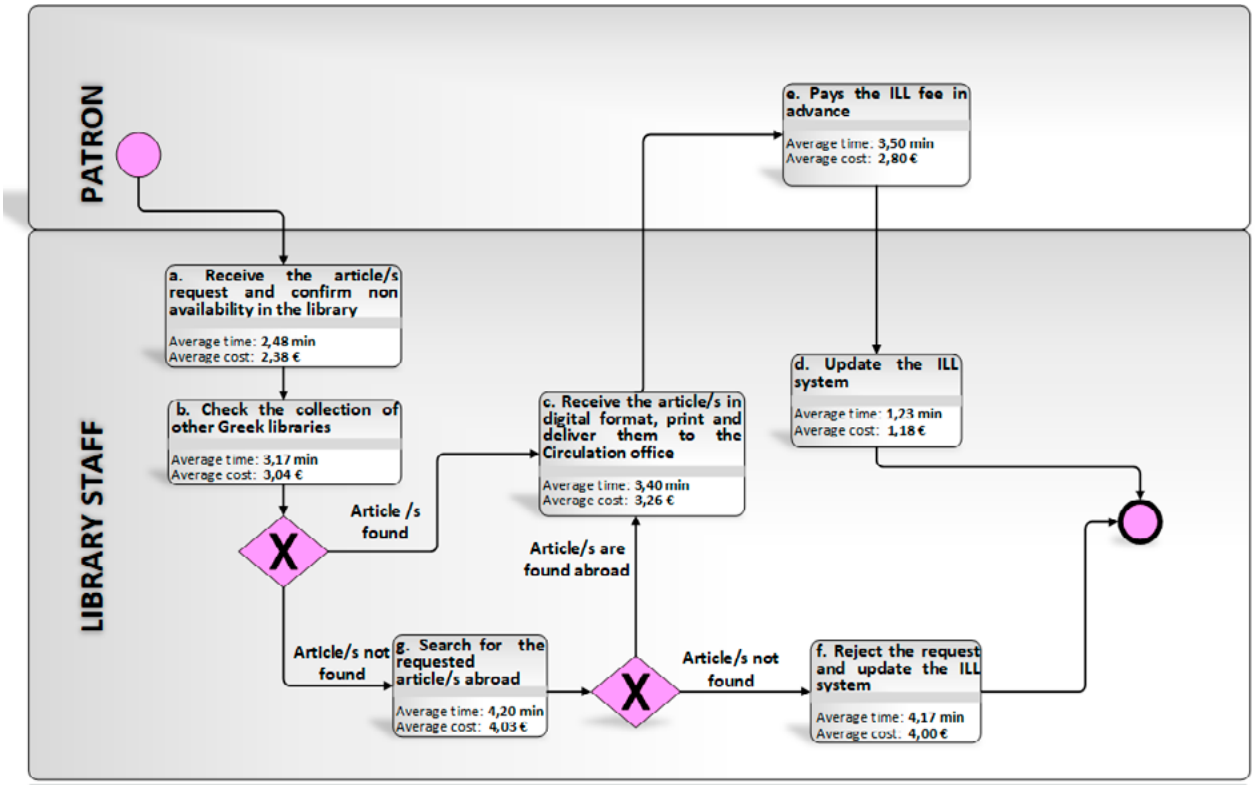
***SUM1 of case C*= a + b + c + d + i + k + h =**2.48 + 3.33 + 3.49 + 1.23 + 4.2 + 1.25 + 3.5 = **19.48 min**

The geographic location of the cooperating library is the most important factor in estimating the cost of outgoing requests for books (table 4). The TDABC analysis shows that if the borrowing library is located in the same city (Thessaloniki), only two activities are involved in the ILL process. In this case, the patron borrows and returns the book to the collaborating library without the participation of the library staff. Thus, the process cost remains low (case A). If the borrowing library is located abroad, the process cost is 12.28% higher (case C) compared to the case where the collaborating library is located in another Greek city (case B).

IV. *Outgoing requests for articles (figure 4)*

When the UoM library staff receive an outgoing request for an article, they check for the requested item in the same way as an outgoing request for a book. When they receive a new request in the IRIS system, they first search and confirm that the article is not available in the UoM library collections and that it is also not freely available online (activity **a** time: 2.48 min).

FIGURE 4
Outgoing Requests for Articles



CASE	TASKS	DESCRIPTION	TOTAL TIME (min)	TOTAL COST (€)
A	a, b, c, e, d	The article/s is/are located in a Greek library	13,78	12,66
B	a, b, g, c, e, d	The article/s is/are located in a foreign library	17,98	16,69
C	a, b, g, f	The UOM library does not possess the requested article/s	14,02	13,45

Then, the UoM library staff search for the requested article through the NDC. If they find it, they forward the request and update the IRIS system (activity **b** time: 3.17 min).

If the UoM library staff do not find the article through the NDC, they check the collections from a foreign library using the BLDSS and Subito systems. If they find it, they forward the request through the BLDSS and Subito, and update the IRIS system (activity **g** time: 4.2 min).

The staff receive the article electronically, issue an invoice, and handle the request through the IRIS system. Then, the patron gets an automated message to receive the article.

The staff prints the article, issues a receipt, and delivers the article to the circulation office where the patron can receive it (activity **c** time: 3.4 min). The patron pays the ILL fee in-person in advance (activity **e** time: 3.5 min). The article remains in the possession of the patron and is not returned. The library staff update the IRIS system after the completion of the ILL process (activity **d** time: 1.23 min). If the cooperating library responds negatively, the UoM ILL staff state that the request is unavailable and update the IRIS system (activity **f** time: 4.17 min).

The resulting equation in minutes for the total time of outgoing requests for articles is as follows:

SUM1= a + **b** + **c** + **d** + **e** + [**f** {if negative} + **g** {if the article is located in the collections of a foreign library}]

There are three cases related to the incoming requests for articles:

Case A: if the article is located in the collections of the NDC:
***SUM1 of case A*: = a + b + c + d + e =** 2.48 + 3.17 + 3.4 + 1.23 + 3.5 = **13.78 min**
Case B: if the article is located in the collections of a foreign library:
***SUM1 of case B*: = a +b+ g + c + d + e** = 2.48+3,17 + 4.2 +3.4 + 1.23 + 3.5 =**17,98 min**
Case C: if the article is not found
***SUM1 of case C*: = a + b + g + f** = 2.48 + 3.17 + 4.2 + 4.17 = **14.02 min**

The geographic location of the cooperating library is a cost determinant. Thus, when the article is found abroad (case B), the process cost is rising (€16.69), compared to the process cost (case A) when the article is located in the collections of the National Documentation Center (NDC) (table 5).

As reported by the results (tables 2, 3, 4 and 5), the borrowing and outgoing request costs for books range from €4.79 to €16.24, while the corresponding costs for articles range from €12.66 to €16.69. The lending and incoming request costs for books range from €2.98 to €9.83, while the respective costs for articles range from €4.29 to €16.70.

Discussion

In this research, we have evaluated the costs of the ILL services at the UoM library in Thessaloniki, Greece. We applied the TDABC method based on the six steps identified by Everaert et al.[47] Our case study showed how a widely applied costing method (i.e., Time-Driven Activity-Based Costing [TDABC]) can evaluate the most important library services, such as the ILL, in an accurate and easy-to-understand way.

The TDABC analysis provides library managers with a detailed costing analysis for each ILL process. As a result, TDABC may help managers reengineer the library processes by identifying the most inefficient or/and expensive activities. For example, in our analysis, the lending (activity b in table 2) and return (activity c in table 2) activities of the process: Incoming requests for books (figure 1) are relatively more time consuming. Since these repetitive activities are considered costly in terms of labor cost, the UoM library managers could automate them with the use of robotic services. Labor cost is the most important cost resource group (table 1), as also reported in previous studies.[48] The ILL cost may be reduced by assigning simple activities to trainee students (SLE), and educate staff on site or by web-based learning.[49,50]

Our ILL cost analysis may also help library managers sufficiently assess the ILL costs and compare them to what the library charges for ILL services. This comparison may help the library administration to accurately estimate the cost efficiency of the IIL processes and change the patron charges accordingly, if necessary. For example, in our analysis, ILL charges do not cover ILL costs in some cases. If the patron is a registered member of the UoM library, the library charges a much smaller fee (i.e. 6 € for book orders) compared to the charge to external users for the exact same process (i.e. €26 – €42). According to our results, the cost of the process ranges from €4.79 to €16.70.

However, our study has a few limitations. The applicability of our results is limited due to various factors such as the size of the library, the different library networks, the software used, and the availability of staff. The study is also limited to public research universities, and may not apply to private higher education institutions.

A suggestion for future research is to analyze ILL processes in other large academic libraries in Greece and/or abroad using the TDABC method. In this way, we can compare the

results of our research with TDABC implementation at other domestic and foreign libraries. Another suggestion is to perform a TDABC analysis of other important academic library services, such as the acquisition service. Although the purchase costs for this service are easy to estimate, the associated acquisition expenses are difficult to evaluate. The use of TDABC may provide important insights for cost improvement.

Conclusions

Our research provides empirical evidence about the effectiveness of the TDABC method in the cost evaluation of a complicated process (i.e. ILL) of an academic library. The TDABC method is effective for library services, since it may evaluate each case of a process with complex time drivers. The TDABC analysis provides managers with accurate, visualized, detailed, and easy to understand information, helping them identify the most and least important (i.e. non-value-added) activities.

The library managers may read and understand the TDABC analysis data effortlessly, given our study's easy-to-understand time equations, cost tables and BPMN diagrams. By implementing a thorough activity analysis, they can evaluate key data such as disaggregated costs per case, and identify which activities are the most time consuming and expensive. The interpretation of the results may also help the managers improve the efficiency of the library processes by saving time and cost. Moreover, they could perform a what-if analysis by adding or removing activities in time equations to evaluate the impact of changes in a process.

In conclusion, this case study contributes to the cost accounting literature by highlighting the usefulness of the TDABC technique in practice. It shows how TDABC may assist library administrators to make strategic decisions about the improvement of the cost effectiveness of the library processes.

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Appendix A

TABLE 2
Incoming Requests for Books

	1. Activity	2. Resource group	3. Average time for each activity (min)	4. Unit cost of the resource group (€/ min)	5. Total activity cost (€)	6. Dummy variable	7 (#)
Standard Activities	**The librarian checks for new submissions to the IRIS system, receives the book request and searches for the requested book**	**Staff labor costs**	1.72	0.80	1.38		**a**
	The librarian finds the book, enters the request to the KOHA and IRIS systems and lends the book	**Staff labor costs**	3.72	0.80	2.97		**b**
	The librarian receives the returned book, places it and updates the KOHA and IRIS systems	**Staff labor costs & LMS costs**	3.46	0.96	3.32		**c**
	Subtotal		**8.9**		**7.67**		
Optional Activities	**The librarian responds negatively to the requesting library and updates the KOHA and IRIS systems**	**Staff labor costs**	2	0.80	1.6	**If the UoM library does not possess the requested book**	**d**
	The patron receives the book from the UoM library	**Staff labor costs**	0.58	0.80	0.46	**If the borrowing library is located in the same city**	**e**
	The book is delivered by courier	**Staff labor costs**	2.70	0.80	2.16	**If the borrowing library is located outside the city**	**f**
Cases	**Case A: a + b + e + c** = 1.38 + 2.97 + 0,46 + 3.32 = € 8.13, **if the borrowing library is located in the same city**						
	Case B: a + b + c + f = 1.38 + 2.97 + 3.32 + 2.16 = €9.83, **if the borrowing library is located outside the city**						
	Case C: a + d = 1.38 + 1.6 = €2.98, **if the UoM library does not possess the requested book**						

TABLE 3
Incoming Requests for Articles

	1. Activity	2. Resource group	3. Average time for each activity (min)	4. Unit cost of the resource group (€/min)	5. Total activity cost (€)	6. Dummy variable	7 (#)
Standard Activities	**The librarian checks for new submissions to the IRIS system, receives the article request and searches for the article in the UoM collections**	**Staff labor costs & LMS costs**	3.06	0.96	2.94		**a**
	The article is delivered through the file upload service	**Staff labor costs & LMS costs**	1.49	0.96	1.43		**b**
	The librarian updates the National Documentation Center ILL system	**Staff labor costs & LMS costs**	1.33	0.96	1.28		**c**
	Subtotal		**5.88**		**5.65**		
Optional Activities	**The librarian rejects the request and updates the ILL system**	**Staff labor costs & LMS costs**	1.41	0.96	1.35	If the article is not available in UoM collections	**d**
	The librarian copies and scans the article	**Staff labor costs & LMS costs**	11.51	0.96	11.05	If the article is available in hard copy	**e**
	The librarian downloads the article	**Staff labor costs & LMS costs**	0.41	0.96	0.39	If the article is available in digital format	**f**
Cases	**Case A: a + b + c + e =** 2.94 + 1.43 + 1.28 + 11.05 = €16.70, **if the article is available in hard copy**						
	Case B: a + b + c + f = 5.65+ 0.39 = €6.04, **if the article is available in digital format**						
	Case C: a + d = 2.94 + 1.35=€4.29, **if the UoM library does not possess the requested item**						

TABLE 4
Outgoing Requests for Books

	1. Activity	2. Resource group	3. Average time for each activity (min)	4. Unit cost of the resource group (€/ min)	5. Total activity cost (€)	6. Dummy variable	7 (#)
Standard Activities	**The librarian receives the request and confirms non availability in the UoM library**	**Staff labor costs & LMS costs**	2.48	0.96	2.38		**a**
	The librarian updates the IRIS system	**Staff labor costs**	1.23	0.80	0.98		**b**
	Subtotal		**3.71**		**3.36**		
Optional Activities	**The librarian informs the patron to receive the book from the UoM library**	**Staff labor costs**	3.33	0.80	2.66	If the borrowing library is located in Greece or abroad, but not in the same city	**c**
	The librarian packs the book and sends it/them to the collaborating library	**Staff labor costs**	3.49	0.80	2.79	If the borrowing library is located in Greece or abroad, but not in the same city	**d**
	The librarian cannot find the requested book. She/ He rejects the request and updates the IRIS system	**Staff labor costs & LMS costs**	4.17	0.96	4.0	If the borrowing library responds negatively	**e**
	The librarian finds the book in the cooperating libraries, after he/ she forwards the request through the IRIS system	**Staff labor costs & LMS costs**	1.49	0.96	1.43	If the borrowing library is located in the same city (Thessaloniki)	**f**
	The librarian finds the requested book in a Greek library which is not located in the same city, and forwards the request through the IRIS system	**Staff labor costs & LMS costs**	3.34	0.96	3.21	If the borrowing library is located in Greece, but not in the same city	**g**
	The patron pays the ILL shipping costs at the library	**Staff labor costs**	3.5	0.80	2.8	If the borrowing library is located in Greece or abroad, but not in the same city	**h**

TABLE 4 (CONTINUED)
Outgoing Requests for Books

	1. Activity	2. Resource group	3. Average time for each activity (min)	4. Unit cost of the resource group (€/ min)	5. Total activity cost (€)	6. Dummy variable	7 (#)
Optional Activities	**The librarian checks and forwards the request through the BLDSS and Subito systems, and updates the IRIS system**	**Staff labor costs & LMS costs**	4.2	0.96	4.03	If the borrowing library is located abroad	**i**
	The return of the lending book is delayed. The librarian notifies the patron about an extra fine cost and to return the book	**Staff labor costs**	1.2	0.80	0.96	If the UoM library staff is informed for a delay	**j**
	The librarian issues a payment receipt	**Staff labor costs**	1.25	0.80	1	If the borrowing library is located abroad	**k**
Cases	**Case A: a + b + f =** 2.38+ 0.98 + 1.43 = €4.79 **if the book is located in the collections of the same city**						
	Case B: a + b + c + d + g + h = 2.38 + 0.98 + 2.66 + 2.79 + 3.21 + 2.8= €14.82, **if the book is located in the collections of a Greek library not located in the same city**						
	Case C: a + b + c + d + i + k + h = 2.38 + 0.98 + 2.66 + 2.79 + 4.03 + 1 + 2.8 = €16.64, **if the book is located in a foreign library**						
	In any case, if the return of the lending book is delayed, an extra cost is (€ 0.96) added (activity j).						

TABLE 5
Outgoing Requests for Articles

	1. Activity	2. Resource group	3. Average time for each activity (min)	4. Unit cost of the resource group (€/ min)	5. Total activity cost (€)	6. Dummy variable	7 (#)
Standard Activities	**The librarian receives the article request and confirms non availability in the UoM library collections or online**	**Staff labor costs & LMS costs**	2.48	0.96	2.38		**a**
	The librarian searches for the requested article through the NDC system and updates the IRIS system	**Staff labor costs & LMS costs**	3.17	0.96	3.04		**b**
	The librarian receives the article electronically, prints it, issues a receipt and delivers it to the circulation office, where the patron will receive it	**Staff labor costs & LMS costs**	3.4	0.96	3.26		**c**
	The librarian updates the IRIS system	**Staff labor costs & LMS costs**	1.23	0.96	1.18		**d**
	The patron pays the ILL fee at the library desk	**Staff labor costs**	3.5	0.80	2.8		**e**
	Subtotal		**13.78**		**12.66**		
Optional Activities	**The article is not available. The librarian rejects the request and updates the IRIS system**	**Staff labor costs & LMS costs**	4.17	0.96	4	If the borrowing library responds negatively	**f**
	The librarian checks the collections of foreign libraries, forwards the request through the BLDSS and Subito systems, and updates the IRIS system	**Staff labor costs & LMS costs**	4.2	0.96	4.03	If the article is located in a foreign library	**g**
Cases	**Case A: a + b + c + d + e =** €12.66, **if the article is located in a Greek library**						
	Case B: a + b + c + d +e + g = 2.38 + 3.04 + 3.26 + 1.18 + 2.8 + 4.03 = €16.69, **if the article is in a foreign library**						
	Case C: a + b + g + f = 2.38 + 3.04 + 4.03 + 4.0 = €13.45, **if the article is not found**						

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