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Library Performance Index (I_{LP}): Multi-Factor Library Performance Evaluation

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Abstract: The Library Performance Index (I_{LP}) is a composite index combining several indicators (sub-indices) derived from complementary views on library services and processes. At the I_{LP} level, the composite index approach enables us to evaluate a complex phenomenon by grouping relevant factors, computing sub-indices of the groups, and computing a weighted sum of those with coefficients assigned by experts. We also apply the composite index approach at the group level, combining the values of the factors within a given group. Such factors can be statistics (e.g., the number of loans), opinions of library professionals (e.g., weighting the attributes of the sub-indices) and opinions of library customers (e.g., results from user surveys). By capturing multiple 'dimensions' of library performance, the I_{LP} can be a valuable and effective tool. We illustrate the approach by dividing a number of library performance-related factors into four groups and computing their respective sub-indices: User Experience Index (I_{UX}), Core Processes Index (I_{CP}), Input Index (I_{IP}), Use of Services Index (I_{US}). Each sub-index was discussed and defined in a dedicated workshop with library directors, developers, and finally the sub-indices were combined to the I_{LP}. While opinions may vary on the contribution of specific factors to the overall library performance evaluation, our primary goal was to demonstrate the flexibility of the composite index-based approach.

Keywords: Composite Index (I_C), Library Performance Index (I_{LP}), User Experience Index (I_{UX}), Core Processes Index (I_{CP}), Input Index (I_{IP}), Use of Services Index (I_{US}), Decision-making Support

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1. Introduction

1.1 Multiple-criteria analysis decision-making

Because the performance of any organization, including a library, is affected by several interrelated factors, examining just one or a few factors may not give a clear enough picture of its performance. This poses the challenge is how much information can be presented concisely, for example, to the library's stakeholders.

Time and space are limited, and there is often no room for multi-indicator presentation in budget and outcome negotiations, and the use of individual indicators may provide incomplete information - a single sub-indicator only indicates a specific part that is related to a larger entity.

So, the need to present plenty of data at the same time has led to the search for new practices. One possible solution is to compile a sum index, or a composite index of several sub-indicators; instead of presenting several indicators separately, the indicators belonging to the same group can be added together to form a holistic picture of the issue being observed.

Several models for measuring the multi-factor performance have been created in different fields and various reviews on multi criterion decision methods and points of view on weighting the attributes used in multiple criteria decision analysis (MCDA) and counting the composite indices have been introduced (Guitouni and Martel 1998, Jia et al. 1998, Kao 2010, Greco et al. 2019).

The concept of using multiple criteria in decision-making and evaluation of library operations is in concordance with the prompt stated by the International Standard ISO 16439 (Information and documentation – Methods and procedures for assessing the impact of libraries) for libraries to develop and test new methods for providing their benefits to clients, frame organization and society (ISO 16439:2014(E);6.4.3).

Laitinen (et al. 2021) illustrated the theoretical framework of evaluation by deriving qualitative data from user surveys and quantitative statistical data to support management and decision-making in the library in the spirit of ISO 16439.

1.2 The Idea of Composite Index

1.2.1 Background

A composite index is a statistical tool that groups together several related indicators or indices to create a representation of the "big picture" of the set of the phenomenon under investigation. Characteristically, the elements of a composite index are combined in a standardized way to enable easy presentation of large amounts of data.

In the course of time, various types of Composite Indices have been constructed to be used by political decision makers, scientists, media, and many other quarters. The indices of the national economy are perhaps the best known among the general public.

OECD (2008) has produced a handbook intended to help the developers of evaluation methodology to better understand the complexity of the Composite Indices and to improve the current technologies.

A glance at Bandura's (2011) fairly a comprehensive inventory on Composite Indicators and Rankings gives some idea of the number of Composite Indices used. One of recent reviews of the methodologic frameworks of composite indices was published by Greco et al. (2019).

1.2.2 Key Definitions and Choices

The composite index definition that we propose is quite simple. Assume we have *k* criteria for estimating a service. We operate with Normalized Weights and Normalized Scores (see below) for each selected criterion. They are combined into a composite index I_c via a linear function: multiplying the Normalized Score for each criterion by the corresponding Normalized Weight and summing all the products together.

$$I_c = \sum_{1}^{k} \left(\text{Normalized Weight} * (\text{Mean} - \text{Minimum Score}) / \text{Range}\right)$$

For the assessment of the service, we need experimental data such as survey results, other forms of feedback, performance statistics, etc. Having the values, we calculate the Mean and normalize it via the Minimum Score and the Range for the given criterion.

Normalized Score = ((Mean - Minimum Score) / Range)

Another ingredient of the composite index I_c is Weight - the 'priority' of the criteria, which we derive from expert opinion. The most important criterion gets the heaviest weight. We normalize the Weights by dividing each of them by their sum and obtain the Normalized Weights (W_R).

Let the Weighted Score for a specific criterion be $S_w = W_R * \text{Normalized Score}$, where W_R is the Normalized Weight of the criterion. Finally, the Composite Index (with i ranging over the set of the criteria), is computed as follows:

$$I_c = \sum_{i=1}^{k} \left(S_{w_i}\right),$$ where k is the number of the criteria

As long as the set of the evaluation criteria and their weights stay the same, we can track the composite indexes over time and study the service quality evolution.

In comparison with Laitinen et al. (2021), we can extend the use of the composite index method to other groups of criteria.

1.2.3 Composite Indices in Libraries

The idea of utilizing the composite index as a tool for assessing the library's performance or the patrons' ways of library use is already adopted in some quarters.

Lee (2018) applied the idea of counting the Reach Index to assess Singapore residents' use of libraries by computing the combined effect of five indicators connected with use of library.

We introduced the idea of measuring the overall experience of a service supplied by a library by computing the User Experience Index (I_{UX}) which is based on seven indicators derived from the library users' responses to the National User Survey (Laitinen et al. 2021).

This was the first step in constructing the Library Performance Index (I_{LP}) that would show the "Big Picture" of library performance by compiling the results of sub-indices basing on the four main dimensions or groups recognized in the library: Core Processes, User Experience, Use of Services, and Input.

2. Method

Constructing the Library Performance Index (I_{LP}) was a multistage process that started in 2019 in library directors' workshop by recognizing and weighting the indicators related to user experience derived from the National User Survey conducted online in the same format in Finland biennially since 2016.

The National User Survey organized by the National Library of Finland covered all Finnish libraries in all library sectors, so all public libraries, university libraries, libraries of universities of applied sciences and special libraries.

The library directors' workshops were organized in cooperation with the National Library of Finland, University of Helsinki and the City of Helsinki as a series of five workshops during the winter 2021-2022 (Table 2). Altogether 167 library directors or experts from all library sectors participated in the workshop series.

A separate workshop to identify library processes was held between the first and second waves. In the workshop, focal processes of library operation were recognized, and they could be placed in four entities or groups, each of which was computed as a composite index during the construction process of the I_{LP} (Table 1).

Table 1. The main groups of the Library Performance Index and their indicators.

User Experience	**Use of Services**	**Input**	**Core Processes**
Utility of the service	Visits (physical + virtual)	Full Time Equivalent (FTE)	Loans
Able to find information	Active borrowers	Acquisition allowance	Downloads
Ease of use	Opening hours (for visitors)	ICT costs	Acquisitions
Time saving	Participants in trainings	Space costs	User training, h
Willingness to recommend (NPS)	Participants in events	Opening hours	Subject cataloguing
Enjoyable to use	--	Floor area	Number of events
Rating the service	--	User training, h	--
--	--	Number of events	--

The indicators included in the main groups listed in Table 1 were weighted in cooperation with library professionals in national workshops to construct four separate composite indices, each of which can be used independently of the

other indices, if desired. Finally, the four composite indices were weighted in assembling workshop to construct the grand total, the Library Performance Index (I_{LP}).

The work was done in five steps or waves, one composite index in each. The five waves and their results are listed in Table 2.

Table 2. Targets and results of the five-step process of constructing the Library Performance Index.

Wave / Workshop	**Result**
1st Wave: Weighting the attributes related to User Experience	User Experience Index (I_{UX})
2nd Wave: Weighting the attributes related to Core Processes	Core Processes Index (I_{CP})
3rd Wave: Weighting the attributes related to Input	Input Index (I_{IP})
4th Wave: Weighting the attributes related to Use of Services	Use of Services Index (I_{US})
5th Wave: Creating the overall picture by weighting the four groups of Library Performance	Library Performance Index (I_{LP})

After each workshop, we summarized the results of the weightings and computed the composite index that applied using the formula shown above.

The weights given by the experts were normalized so that sum of the Normalized Weights (W_R) is 1. To compute each of the sub-index, the Measured Scores (S) were derived from results of user survey or from library statics. The Measured Scores were the normalized in relation to the scale used:

$$S_{norm} = \frac{S - S_{min}}{L},$$

where

- S_{norm} is the Normalized Score
- S is the Measured Score from user survey or evaluation value given by the library
- S_{min} is the minimum value of the scale used
- L is Range Length of the scale used

The value of the index is the sum of weighted values between 0 and 1.

In Wave 1 for computing the User Experience Index (I_{UX}), the Measured Scores (S) were derived from user survey.

In waves 2 to 4 for computing the Use of Services Index (I_{US}), the Input Index (I_{IP}) and the Core Processes Index (I_{CP}), the Measured Scores (S) were based on the estimate given by the library on the data derived from library statistics. The estimate based on the question "How good is the measured statistical value on the given scale?" This was needed because, naturally, it is not possible to define a scale limit on statistical data.

Finally, the Weighted Scores (S_W) of the attributes were computed: $S_W = W_R * S_{norm}$.

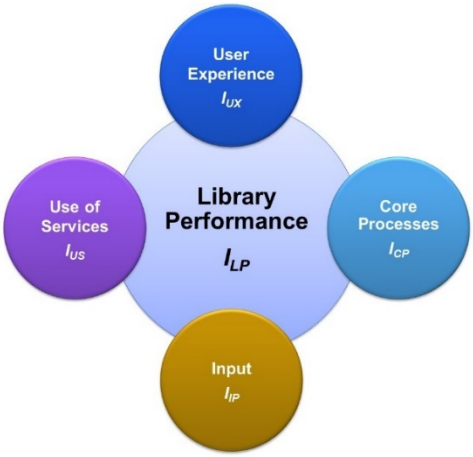

Figure 1. The four main groups of the Library Performance Index (I_{LP}).

3. Results

3.1 Wave 1: User Experience Index (I_{UX})

The weights of the seven attributes or indicators of the User Experience Index (I_{UX}) and the measured scores (S) derived from the National User Survey and their Normalized (S_{norm}) and Weighted (S_W) Scores are shown in Table 3. The graphic description of I_{UX} weighted scores is shown in Figure 2.

Table 3. **The attributes of the User Experience Index (I_{UX}). The weights produced at the library directors' workshop were normalized and scaled by the Normalized Scores (derived from the user survey results) to compute the Weighted Scores (S_W) of each attribute. The sum of the Weighted Scores is the value of I_{UX}.**

Attribute	**Weight**	**Normalized Weight (W_R)**	**Measured Score (S)**	**Scale**			**Normalized Score (S_{norm})**	**Weighted Score (S_W)**
				S_{min}	S_{max}	**Range (L)**		
Useful	90.8	0.175	4.56	1	5	4	0.891	0.156
Able to find	90.0	0.174	4.08	1	5	4	0.769	0.134
Easy to use	78.9	0.152	4.06	1	5	4	0.766	0.117
Saves time	74.2	0.143	4.24	1	5	4	0.809	0.116
Want to recommend	71.3	0.138	56.42	-100	100	200	0.782	0.108
Enjoyable	56.7	0.109	4.08	1	5	4	0.770	0.084
Rating	56.3	0.109	8.30	0	10	10	0.830	0.090
Weight Sum	**518.1**	**1.000**					I_{UX}	**0.804**

Measured Score (S) is the result from user survey

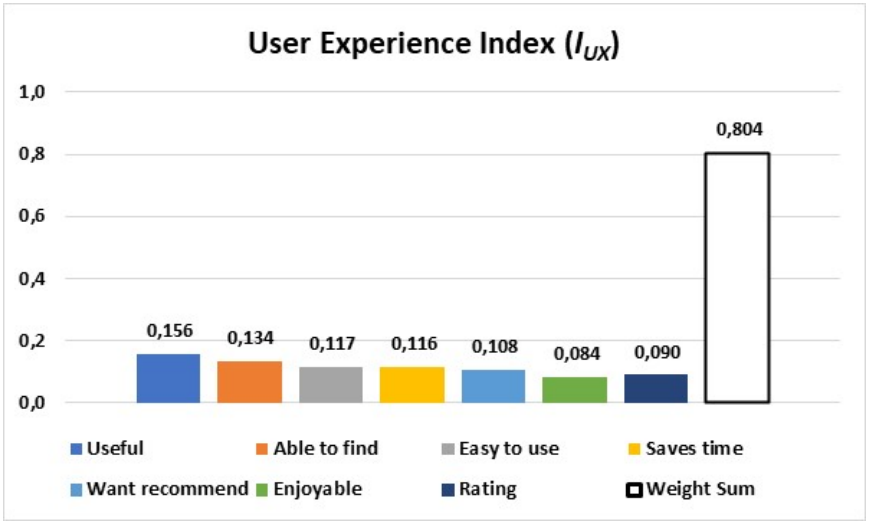

Figure 2. User Experience Index of a search portal. The indicators are listed from left to right in the order of the weights given by the experts. "Useful" and "Able to find" are of highest weight.

3.2 Wave 2: Core Processes Index (I_{CP})

The weights of the six attributes of the Core Processes Index (I_{CP}) and the assessed ratings (S) of the statistical data, and their Normalized (S_{norm}) and Weighted (S_W) Scores are shown in Table 4. The graphic description of I_{CP} weighted scores is shown in Figure 3.

Table 4. The attributes of the Core Processes Index (I_{CP}). The weights produced at the library directors' workshop were normalized and scaled by the Normalized Scores (derived from the assessments (S) of the Measured Scores) to compute the Weighted Scores (S_W) of each attribute. The sum of the Weighted Scores is the value of I_{CP}.

Attribute	Weight	Normal-ized Weight (W_R)	Measured Score (From statistics)	Assess-ment (S) (*	Scale			Normal-ized Score (S_{norm})	Weight-ed Score (S_W)
					S_{min}	S_{max}	Range (L)		
Loans	90.7	0.199	18 708	8.00	1	10	9	0.778	0.155
Downloads	90.7	0.199	7 917	4.00	1	10	9	0.333	0.066
Acquisitions	82.5	0.181	22 647	9.00	1	10	9	0.889	0.161
User training, h	76.0	0.167	240	10.00	1	10	9	1.000	0.167
Subject cataloguing	62.0	0.136	57 143	8.00	1	10	9	0.778	0.106
Number of events	54.5	0.119	12	7.00	1	10	9	0.667	0.080
Weight Sum	**456.4**	**1.000**						I_{CP}	**0.733**

*) **Expert assessment based on the statistics: "How good is the statistical value on the given scale?"**

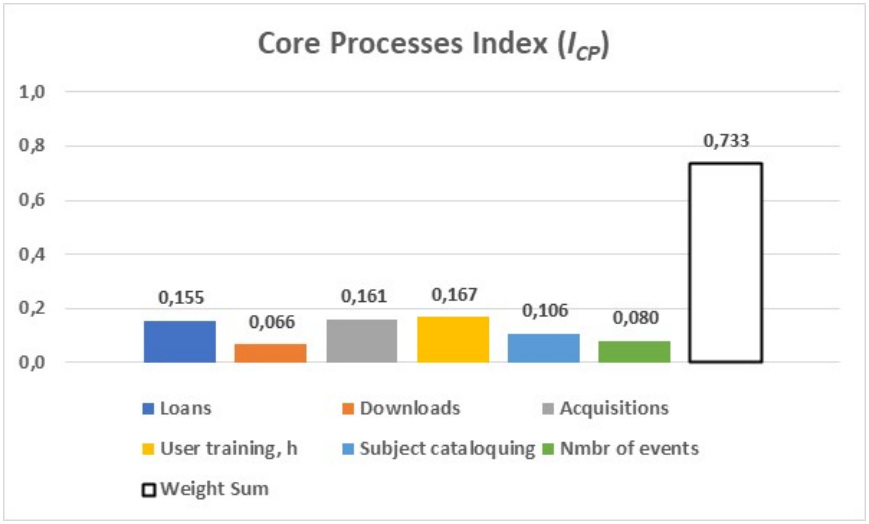

Figure 3. Core Processes Index. The indicators are listed from left to right in the order of the weights given by the experts. "Acquisitions", "User training" and "Loans" bring the largest contributions to I_{CP}.

3.3 Wave 3: Input Index (I_{IP})

The weights of the eight attributes of the Input Index (I_{IP}) and the assessed ratings (S) of the statistical data, and their Normalized (S_{norm}) and Weighted (S_W) Scores are shown in Table 5. The graphic description of I_{IP} weighted scores is shown in Figure 4.

Table 5. The attributes of the Input Index (I_{IP}). The weights produced at the library directors' workshop were normalized and scaled by the Normalized Scores (derived from the assessments (S) of the Measured Scores) to compute the Weighted Scores (S_W) of each attribute. The sum of the Weighted Scores is the value of I_{IP}.

Attribute	Weight	Normalized Weight (W_R)	Measured Score (From statistics)	Assessment (S) (*)	Scale			Normalized Score (S_{norm})	Weighted Score (S_W)
					S_{min}	S_{max}	Range (L)		
FTE	98.9	0.176	18.03	8.0	1	10	9	0.778	0.137
Acquisition Allowance	95.0	0.169	174 429.00	8.1	1	10	9	0.789	0.133
ICT Costs	80.3	0.143	1 259.00	6.9	1	10	9	0.656	0.094
Space Costs	73.3	0.130	349 140.00	4.0	1	10	9	0.333	0.043
Opening Hours	69.7	0.124	16 309.00	5.0	1	10	9	0.444	0.055
Floor Area	56.7	0.101	3 402.00	8.5	1	10	9	0.833	0.084
User Training, h	45.7	0.081	58.00	2.0	1	10	9	0.111	0.009
Number of Events	42.9	0.076	160	7.5	1	10	9	0.722	0.055
Weight Sum	**562.3**	**1.000**						I_{IP}	**0.610**

*) **Expert assessment based on the statistics: "How good is the statistical value on the given scale?"**

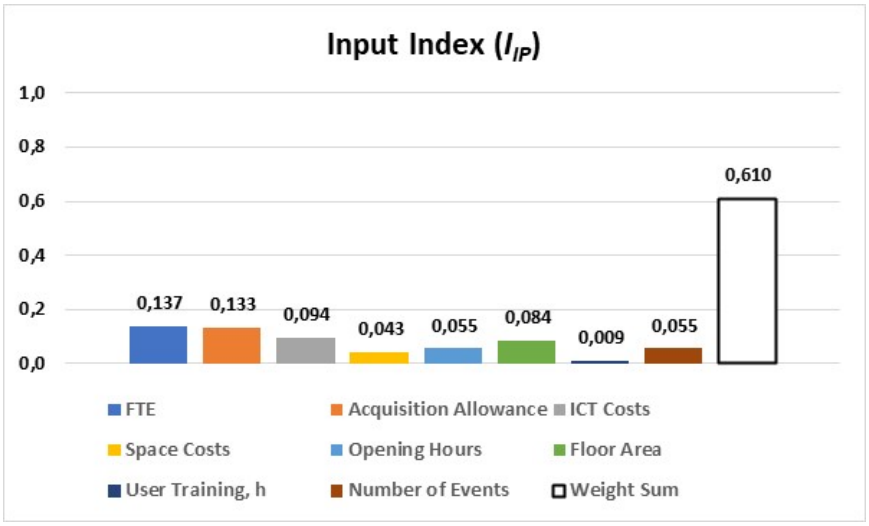

Figure 4. Input Index. The indicators are listed from left to right in the order of the weights given by the experts. "Full Time Equivalent (FTE)" and "Acquisition Allowance" bring the largest contributions to I_{IP}, followed by "ICT Costs" and "Floor Area".

3.4 Wave 4: Use of Services Index (I_{US})

The weights of the five attributes of the Use of Services Index (I_{US}) and the assessed ratings (S) of the statistical data, and their Normalized and Weighted Scores (S_W) are shown in Table 6. The graphic description of I_{US} weighted scores is shown in Figure 5.

Table 6. The attributes of the Use of Services Index (I_{US}). The weights produced at the library directors' workshop were normalized and scaled by the Normalized Scores (derived from the assessments (S) of the Measured Scores) to compute the Weighted Scores (S_W) of each attribute. The sum of the Weighted Scores is the value of I_{US}.

Attribute	Weight	Normal-ized Weight (W_R)	Measured Score (From statistics)	Assess-ment (S) (*)	Scale			Normal-ized Score (S_{norm})	Weight-ed Score (S_W)
					S_{min}	S_{max}	Range (L)		
Visits (physical + virtual)	98.9	0.256	15,000	8.00	1	10	9	0.778	0.199
Active borrowers	87.6	0.227	6,482	8.50	1	10	9	0.833	0.189
Opening hours	73.2	0.190	62.0	9.00	1	10	9	0.889	0.169
Participants in trainings	71.6	0.185	1,782	7.00	1	10	9	0.667	0.124
Participants in events	54.7	0.142	1,328	7.50	1	10	9	0.722	0.102
Weight Sum	**386.1**	**1.000**						I_{US}	**0.783**

***) Expert assessment based on the statistics: "How good is the statistical value on the given scale?"**

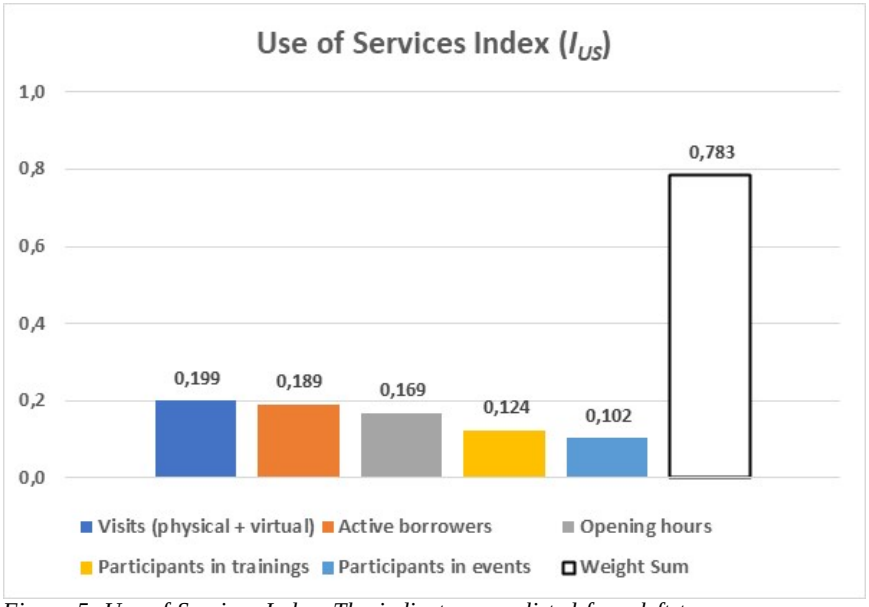

Figure 5. Use of Services Index. The indicators are listed from left to right in the order of the weights given by the experts. "Visits", "Active borrowers" and "Opening hours" bring the largest contributions to I_{US}.

3.5 Wave 5: Put it all together – the Library Performance Index (I_{LP})

The Library Performance Index (I_{LP}) is a composite index obtained from the four sub-indices (I_{UX}, I_{CP}, I_{IP} and I_{US}). So, I_{LP} shows the simultaneous (but weighted) effect of the 26 indicators on library performance as a whole. The weights and the Measured Scores (S) of the four sub-indices and their

normalized Weighted Scores (S_W) are shown in Table 7. The graphic description of I_{LP} weighted scores is shown in Figure 6.

Table 7. The grand total of library performance, the Library Performance Index.

Attribute	Weight	Normalized Weight (W_R)	Measured Score (S)	Weighted Score (S_W)
User Experience	94.8	0.272	0.804	0.219
Core Processes	89.2	0.256	0.733	0.188
Use of Services	85.0	0.244	0.783	0.191
Input	79.7	0.229	0.610	0.139
Weight Sum	**348.7**	**1.000**	I_{LP}	**0.737**

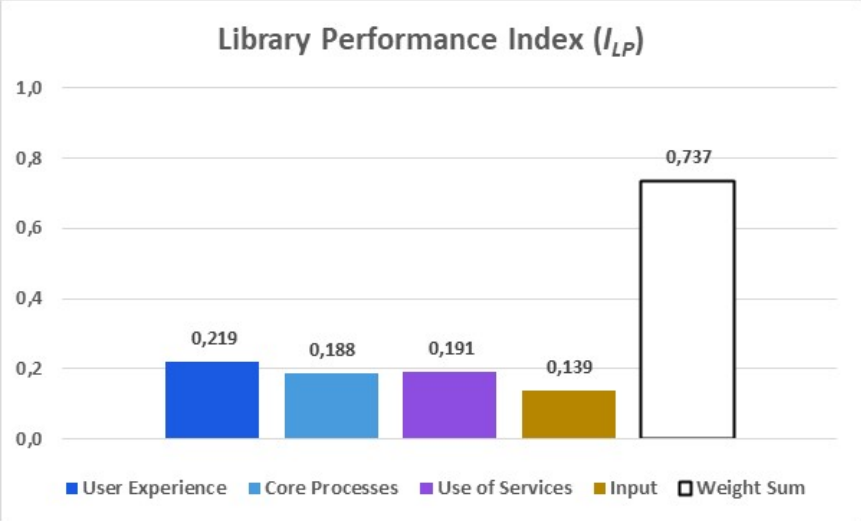

Figure 6. The grand total of library performance, the Library Performance Index. The sub-indices are listed from left to right in the order of the weights given by the experts. "User Experience" and "Use of Services" bring the largest contributions to I_{LP}, followed closely by "Core Processes".

4. Discussion

The kind of analysis we did is so far little known in the library world. Kao & Hung (2003) made a two-step analyse of twenty-four university libraries weighting the attributes using a posteriori method. Our approach was to weight the attributes a priori.

The kind of analysis we did is so far little known in the library world. In Taiwan, multi-criteria analysis was used to rank twenty-four university libraries to produce a composite index (Kao et al. 1998, Kao & Hung 2003, Kao & Lin 2004). In these studies, the goal was to find the optimal set of weights to produce the highest composite index values for the libraries.

In these studies, from the weights and the measures of the criteria, a weighted average was calculated for each library to produce the composite index for comparison among the libraries.

In our research, we demonstrated applicability of presenting the simultaneous effect of 26 indicators belonging to the same group to form a holistic picture of the issue being observed.

Each of the sub-indices developed in waves 1 to 4, which in themselves are composite indices, can be used separately. Due to the computing method developed by us, the four indices can also be compiled into the I_{LP}, the weightings of which were decided in the 5^{th} wave.

An obvious advantage of using the composite index is the opportunity to reflect jointly several aspects of the phenomenon under observation, yet in such a way that the contributions of the individual aspects can be prioritized.

Being the attributes of the composite index carefully selected, it is possible to have a good and realistic picture of library performance and impact on society or its frame organization. Other obvious uses are budget and performance negotiations. So, we consider the composite index suitable both for reporting and strategic planning.

For time series monitoring, the indicators and their weights should be kept unchanged long enough to maintain comparability. Yet, it is also important to keep the index up to date so that the individual component factors of the index and their weights correspond to the need for the time of measurement.

We chose to weight the attributes of the indices a priori, so the weights of the attributes were given in the library experts' workshops before application to practice. The a priori weighting is supported by the fact that the tool we have developed is intended not only to monitor the library's own activities, but also as a benchmarking tool. After having practical experience, it may be useful to inspect the weights again, a posteriori, as Kao & Hung (2003) did. Checking the weights a posteriori may reveal the need to rethink the weights of some attributes.

On the point of view of the libraries, the method we chose for weighting the attributes was probably easiest to adopt by the attendants in the workshop meetings. Further, because our intention is to encourage the independent use of

the I_{LP} in libraries as a part of their performance assessment, we think the method we introduce in this paper is simple enough to be adopted for regular use.

Another method used in evaluation is the Analytic Hierarchy Process (AHP) introduced by Saaty (1990). Although we did not choose this method for our study, we think it could be interesting to test AHP for calculating the linear form coefficients of composite indexes applied to library performance evaluation. The priorities that are calculated for the elements of any of the levels of the hierarchical structure of the AHP method can be used as coefficients for the creation of a composite index (Sirikrai and Tang, 2006).

To produce a good user experience, the seamless operation of the library's core processes is important to enable the fluent use of services that meet the needs of customers. These are ensured by adequate and properly targeted input.

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