

A Database Model for Increasing the Success of Interior Design in Open Plan Offices in Terms of Acoustic Comfort

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Abstract

The relation between office interior design and employee performance has been an important area of research since many years. Many institutions have been trying new designs and techniques in new buildings within the purview of the studies done in this regard with an eye to increase the efficiency of their employees as well as retaining their employees by attracting them. To this end, the purview and purpose of this study have been determined as proposal of a database model for increasing the success of interior design in open plan offices in terms of acoustic comfort. Whom and how the data base model will be utilized as the study's methodology has been described at the first stage. Subsequently, classification systematic of the database model has been created. The database model has been fictionalized in a holistic way basing on this classification systematic at the final stage. It is ensured to have access to design rules created as a result of various scientific studies as to increase interior design success in open-plan offices in terms of acoustic comfort by virtue of the proposed database model proposed within the purview of the study. Furthermore, it will be also enabled to reach information needed in application of design rules in the database and as to the products or materials sold in the sector. In other words, it will be possible to see which design rule will be able to be realized by which material or product and company information as to them will be made available. In addition, numerous different statistical results such as graphic of registration on the basis of design rule classes, number of design rules on the basis of products, will be able to be obtained thanks to the proposed database model. Such results will be able to be employed for different purposes in both academic and sectoral levels.

Keywords: Open-plan office, noise and sound control, employee performance, office interior design, performance-based design

INTRODUCTION

"Office interior", unlike other places, has a different significance for human life considering the time spent therein [1; 2; 3; 4]. The relation between office interior design and employee performance has been an important area of research since many years. Many institutions have been trying new designs and techniques in new buildings within the purview of the studies done in this regard with an eye to increase the efficiency of their employees as well as retaining their employees by attracting them. Employee needs in other words user requirements in the office interiors designs have begun to be taken into consideration much more to this end. [5; 6]. Govindarajulu and Bonnie [7] state on this issue that the businesses in the 21st century show a strategic approach in environmental management to increase their efficiency by raising the performance level of the employees [8]. In other words, satisfaction of the employees with the

office space in our day is considered as an important factor in the success of an institution and an effective indicator for increasing the performance of the employees. This finding is supported by the research conducted through Dole and Schroeder in 2001 which has revealed that the employees who are satisfied of the physical work space at their work places accomplish better results in their works [9]. Moreover, it is also declared in the findings of the research carried out through Patterson et.al. [10] that the companies with more satisfied employees, are likely to achieve better jobs, especially in terms of productivity and profitability [8].

New requirements as to the advancement of technology, increase in the number of employees, development of different work models and the needs for using the space more efficiently have led to variations in arrangement of interior of offices. And this has necessitated categorizing the types of office plans to evaluate the relation between employee performance and interior arrangement correctly.

It can be observed that types of office plans are basically categorized in five different ways as a result of literature researches made in this context [9;10; 12; 13; 14; 15; 16; 17; 18; 19; 20; 21; 22]. These office plan types are the combination of data in the table named "Office types defined by different architectural and functional features" used in "Office type in relation to health, well-being and job satisfaction among employees" article of Bodin of Danielsson and Bodin [11] and data in the book of Van Meel, et al. [23] named "Planning office spaces: a practical guide for managers and designers" which is titled as "Cell office, shared office, open plan office, flexible office and combi office"

It has been revealed that offices are of particular importance compared to all other spaces in terms of human-space relation and office interior design has been found to be very effective in terms of employee performance as a result of all this literature work carried out. Furthermore, it has been identified that the office plan types have to be considered to describe the relation between employee performance and office interior design correctly.

PURPOSE AND METHODOLOGY

The purview and purpose of this study have been determined as proposal of a database model for increasing the success of interior design in open plan offices in terms of acoustic comfort. The reason of limitation of this study with "open-plan office" is that 70% of all office plan types in the world are consisted of "open-plan offices" in terms of intensity of use [24; 25]. The reason of discussing acoustic comfort in interior design is Karaaslan and Yazıcıoğlu's [26] determination of "in-office noise" as the most important factor affecting the employee performance in open-plan offices by 56%. It will be described at the first stage by whom and in what way the data base model will be used as the study's methodology. Subsequently, classification systematic of the database model will be created. The database model will be fictionalized in a holistic way basing on this classification systematic at the final stage.

DETERMINATION OF HOW AND BY WHOM THE DATABASE MODEL WILL BE UTILIZED

The main purpose of the database model which will be proposed for improving the performance of interior design in terms of acoustic comfort in open-plan offices is establishing the relation between developments in the sector and the scientific studies carried out on this subject and to provide access of information to relevant parties. Accordingly database model will be able to be used as shown in Table 1.

Table1. Utilization of the database model

User	Means of usage
Interior architect-practician	They will be able to reach the design rules created as a result of a variety of scientific studies in the literature for increasing interior design performance in terms of acoustic comfort in open-plan offices and use them at different stages of their projects.
	They will also be able to have access to information as to design rules in the database obtained by various scientific studies and as to the products or materials sold in the sector. In other words, it will be possible to see which design concept can be performed by which the material or product and will also be able to have access to company information of foregoing.
Academician	They will be able to have access to all of the scientific studies on the subject systematically.
	They will be able to see in which areas the relevant scientific studies have been conducted intensively and rarely. This will help the academics to determine the studying areas more accurately.
	They will be able to see which scientific studies conducted on the subject correspond to the products or materials in the sector.
	They will be able to add the scientific studies they have conducted on the subject to this data base and establish the sectoral relation with the study subject thereof.
Sector	The sector will be able to follow scientific studies that have been conducted as to the products or materials in the sales line thereof and use them in their product R & D works.
	The sector will be able to enter the information as to new products to the database and establish the relation between these information and the academic studies.

DETERMINATION OF CLASSIFICATION SYSTEMATIC OF THE DATABASE MODEL

Systematic classification of the design rules to be included in the database will be firstly identified in order to determine by which classification systematic the database model will be configured. Later, it will be determined how the relation will be established between the information of the product or materials which are required and which are sold in the sector in the process of application of these design rules.

Determination of Classification Systematic of Design Rules

The following steps will be taken with a view to determine the systematic classification of the design rules in the literature which will be obtained by virtue of the scientific studies:

- a. Determining the stages of the open-plan office interior architecture projects: For determination of the stage of design rules in the database
 - b. Determination of the interior components of the open-plan office spaces and activity areas: For identification of which design rules in the database belong to the which interior components
- a. Determining the stages of the open-plan office interior architecture projects
Phases of the interior design project basically consist of five stages disregarding the size and purview of the project. These are respectively as follows [27]:
 - Preliminary preparation stage
 - Schematic design stage
 - Design development stage
 - Approval stage by preparation of official documents

- Application stage

Preliminary preparation stage, schematic design stage and design development stages of interior design project stages defined hereinabove will be utilized mainly when configuring the database model which will be proposed for increasing the interior design performance in terms of acoustic comfort in open-plan offices and they will be titled as follows:

- Preliminary preparation stage
- Determination of user requests and requirements
- Analysis of space
- Design stage

The approval stage by preparation of official documents and application stage will be excluded from the scope of the database model. The reason for this is that the model database will not include information and application techniques as to official proceedings for improving acoustic comfort.

- b. Determining the interior architecture components of the open-plan office spaces and activity fields
 Determining the interior architecture components of open-plan office spaces and interior components of the activity areas it belongs to is necessary to determine which design rules in the database belong to which interior architecture components. The results provided from literature research carried out to this end were observed to be as Table2.

Table 2. Interior architecture components of open-plan office spaces and activity areas

References	Spaces and activity areas in open-plan offices
[28]	Entrance / Reception Individual (cellular) office Cubicle Open office Meeting rooms Conference rooms Open activity, rest and working areas for everyone Copier and printer Kitchen Toilet
References	Interior architectural components of spaces and activity areas in open-plan offices
[29; 30]	Floor Wall Ceilling Mobile and stationary dividing element Furnitures Doors Windows Installition Sound systems Lighting elements Accessories

Design rules classification systematic in the database model in line with all these results obtained are structured as specified in Table3.

Table 3. Classification systematic of products or materials of companies within the data base model

Main group	Sub-group	Design Rule No	References
Preliminary preparation stage	Determination of user requests and requirements Analysis of space	KU01, KU02,... M01, M02,...
Design stage	Space and activity areas in open plan offices Entrance / Reception Individual (cellular) office Cubicle Open office Meeting rooms Conferance rooms Open activity, rest and working areas for everyone Copier and printer Kitchen Toilet	G01,G02,... H01, H02,... C01,C02,... AÇ01, AÇ02,... T01, T02,... KS01, KS02,... OA01, OA02,... F01, F02,... MU01, MU02,... TU01, TU02,...
	Interior design components for sapce and activity areas in open plan offices Floor Wall Ceilling Mobile and stationary dividing element Furnitures Doors Windows Installition Sound systems Lighting elements Accessories	D01, D02,... DU01, DU02,... TA01, TA02,... B01,B02,... M01, M02,... K01, K02,... P01, P02,... TS01, TS02,... SS01, SS02,... A01, A02,... AK01, AK02,...

Creation of Systematic for Establishment of Relation between Design Rules and the Sector
It has to be determined firstly how the data sets in which the products or the materials of the companies will be included will be structured for the creation of systematic for establishment of the relation of the design rules and the sector. To this end, a market research was carried out at this stage of the study and it was decided to make the structure as shown in Table4 in line with the results obtained.

Table 4. Classification systematic of products or materials of companies within the data base

Design Rule no	Name of Product/Material	Web address of Product/Material	Firm Name	Firm contact information	Firm web address
OA01					
D06
TS03					
.....					

The relation between the design rules set classification systematic of which is defined in Table3 and products or materials systematic of companies systematic of which are defined in Table4 will be established by the code defined as " Design clue no. "

FICTIONALIZING THE DATABASE MODEL

Conceptual model has been transformed into a relational database model in objective model size basing on the output of the works within conceptual dimension hereinabove and by using Microsoft Access Relational Database Development Platform. The tables in which the information is organized within the scope of model in conceptual dimension and the relation between them can be seen in Relationships Screen in Figure 1.

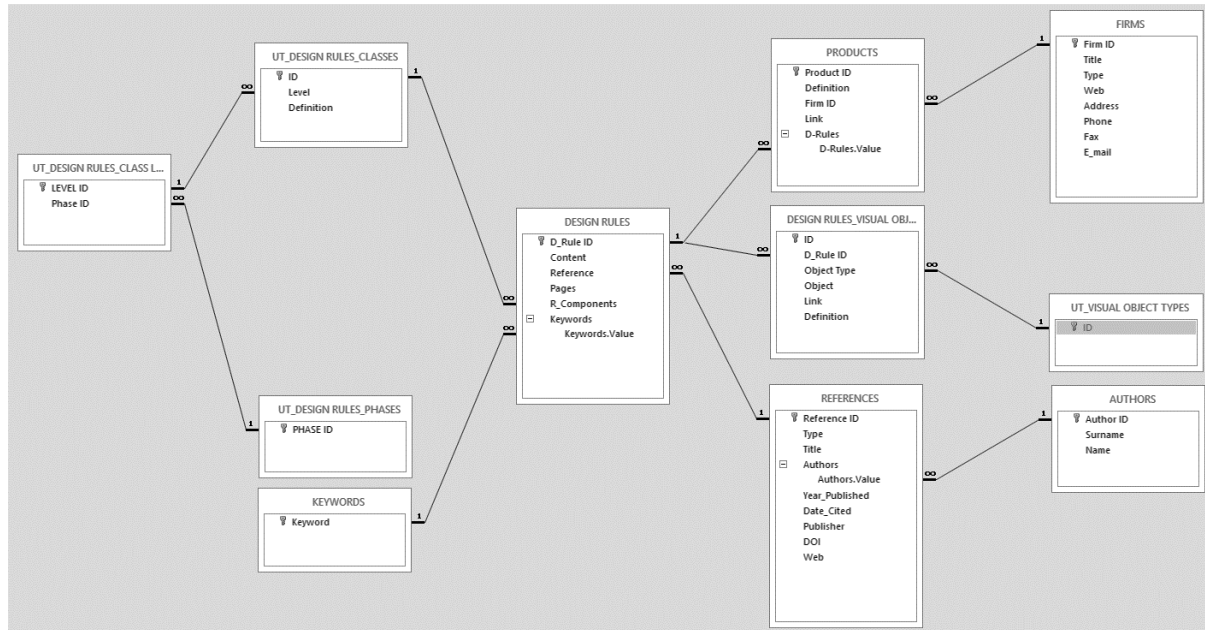


Figure 1. The relationships screen representing the conceptual structure of the model: Relationships between tables and relational database architecture

The model provides access to a large number of interfaces fictionalized as modules by an Opening Interface reached at the beginning (Figure 2). These modules are listed below:

- Design Rules Module
- Products and Companies Module
- References and Authors Module
- Supporting Objects Module
- Reporting Module

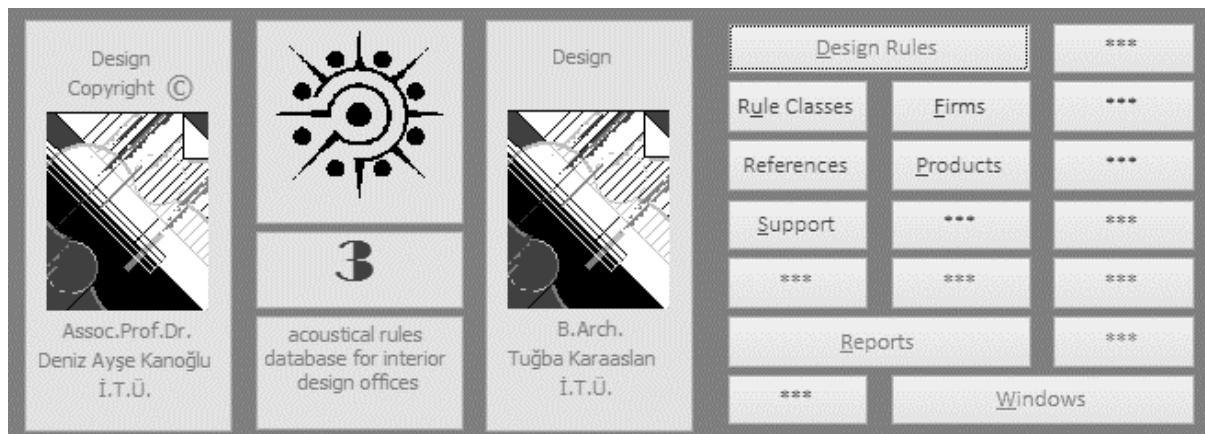


Figure 2. The opening interface

Design rules determined from the literature and transferred to the system can be seen as a list in Design Rules Interface Display and Filtering Interface accessed from the opening interface (Figure 3); selections made from the parameter groups in the drop box located on the right side can be reported by filtration with the desired parameters (reference publication design class rules, keywords).

D_Rule ID	Content	Reference	Pages	R_Components	Keywords
A_01	Tavan yansımaları, 1970' lerde yaygın olarak kullanılan ve özellikle workstationlar arasında bulunan "kusuurlu bölgelerde	RF_003		A	NA
A_02	Apık planlı ofislerin tasarımı esnasında aydınlatma armatürleri belirlerken, sesin armatür yüzeyi üzerinden yansımaları	RF_000		A	NA
A_03	Apık planlı ofislerin tasarımı esnasında aydınlatma armatürlerinin belirlemesinde, sesin armatür yüzeyi üzerinden yansı	RF_000		A	NA
A_04	Apık (parabolik panjurlu lambalar) aydınlatma armatürleri sesi dağıtmaktadır (Alkan, 2008; Yüce, 2009). Bu apık	RF_000		A	NA
A_05	Derin hücreli parabolik aydınlatma armatürleri, zamanla daha iyi ipik kalitesi sağlamakta, daha az güç gerektirmekte ve	RF_000		A	NA
A_06	Apık planlı ofis tasarımı yapılırken, asma aydınlatma armatürleri için delikli ya da dipbükey yüzeylerden oluşan tipler teri	RF_000		A	NA
A_07	İndirekt lambalar (çalışma birimlerinde bölme üstüne yerleştirilen dolaylı aydınlatma fişkürleri), birimlerine bağlı olar	RF_000		A	NA
AC_01	Apık ofis alanlarının iç mekan düzenlemesinde, akustik anlamda mahremiyet ve kapallılık seviyesini yükseltmek için duv	RF_000		AC	NA
AC_02	Apık ofis alanlarında, çalışma istasyonu, geçiş alanı, donanım yerleri vb. özel ve genel alanları tanımlamak için bölmeler	RF_000		AC	NA
AC_03	Apık ofis yerleşimi dolayısı ile kolaylaştırıcı nitelikte alanlardır (Alkan, 2008). Aksi takdirde dolayım yollarının kullanı	RF_000		AC	NA
AC_04	Apık ofis alanlarında özellikle yüksek konsantrasyon gerektirilen alan çalışma alanları, genel alanlardan ve yoğun trafikt	RF_000		AC	NA
AC_05	Apık ofis alanlarında, yeterli düzeyde mahremiyetin sağlanabilmesi için, çalışma birimleri birbirlerine uygun mesafede	RF_000		AC	NA
AC_06	Apık ofis alanlarında, yeterli düzeyde mahremiyetin sağlanabilmesi için, çalışma birimleri birbirlerine uygun mesafede	RF_000		AC	NA
AC_07	Apık ofis alanlarında kullanılan bölmelere yakın yerleştirilmelidir. Böylece defraksiyon (kırılarak yayılım) apık çok büy	RF_000		AC	NA
AC_08	Apık ofislere ait iç mekan düzenlemesi yapılırken takım çalışmasının gerçekleştirileceği alanlarda, küçük ve alçak banyerler	RF_000		AC	NA
AC_09	Apık ofislerde yer alan tüm paneller ve diğer geniş yüzeyler için malzeme seçimi yapılırken ses emicilik değerinin SAA (Sou	RF_000		AC	NA
AC_10	Apık ofislerde tavanelarla ilgili malzeme seçimi yapılırken ses emicilik değerinin SAA (Sound Absorption Average) ≥ 0.	RF_000		AC	NA
AC_11	Kapalı ofis düzeninden apık ofis düzenine geçiş, sadece mekansal değil, aynı zamanda kültürel bir dönüşüm olduğundur	RF_000		AC	NA

Figure 3. Design rules monitoring and filtering interface

Reference publication information, design rules for class information and keywords can be defined in the Interface Design Rules Definition reached from here by selecting from the relevant tables and by relating with the selected design rule (Figure 4).

Design Rule ID AC_08

Reference RF_000

Comment AC

Keywords NA

Content
Apık ofislerde ait iç mekan düzenlemesi yapılırken takım çalışmasının gerçekleştirileceği alanlarda, küçük ve alçak banyerler kullanılabilir. Bu tasarım yaklaşımı, yakın mesafede bulunan çalışanlar arasındaki görüşmelerin engellenmesine yardımcı olurken, aynı zamanda apık plan ofis ortamının verimsiz olduğu algısına nispeten berye kaybetmeden konuma gelişinin arttırılmasını sağlamaktadır. Ancak bu şekilde yönlendirilmiş bir yerleşim düzeni oluşturulduğu takdirde, çalışanların yüzüze bakabilecekleri bir durum yaratılmadan kaçınılmazdır ve mesafe mümkün olan en üst düzeyde piklanmalıdır.

Figure 4. Design rules defining interface

Products Interface is the second interface which can be accessed through the opening interface. In this section, the products existing in the market can be recorded by relating to design rules which have been identified in the literature and transferred to the system (Figure5).

Product ID	Definition	Firm ID	Link	D-Rules
ECO_ACUSTA_SCR	Ecophon Akusto™ Screen	SGE	http://www.ecophon.com/en/products/Vertical-applications/Akusto/	AC_02, AC_09, AK_01, B_03, DU_01, DU_04, DU_05, F_01, F_02, F_03, F_04, H_03, MB_03, OA_01, OA_02, OA_04, OA_05, T_01, T_05, T_08
ECO_ACUSTA_WP	Ecophon Akusto™ Wall Panel	SGE	http://www.ecophon.com/en/products/Vertical-applications/Akusto/	AC_02, AC_09, AC_09, B_02, B_02, B_03, B_05, B_08, B_10, H_03, MB_03, OA_01, OA_02, OA_04, OA_05, T_01, T_05, T_08
ECO_COMBISON	Ecophon Combison™	SGE	http://www.ecophon.com/en/products/Modular-ceilings/Combison/	G_01, G_02, H_02, MB_03, OA_01, OA_02, OA_05, T_01, T_05, T_08
ECO_FOCUS	Ecophon Focus™	SGE	http://www.ecophon.com/en/products/Modular-ceilings/Focus/	MB_03, TA_04, TA_05, TA_07, TA_13
ECO_GEDINA	Ecophon Gedina™	SGE	http://www.ecophon.com/en/products/Modular-ceilings/Gedina/	AC_10, AK_01, F_01, F_02, G_01, G_02, K_04, K_10, K_15, T_08
ECO_MASTER	Ecophon Master™	SGE	http://www.ecophon.com/en/products/Modular-ceilings/Master/	T_08
ECO_MASTER_ALPHA	Ecophon Master™ Alpha	SGE	http://www.ecophon.com/en/products/Modular-ceilings/Master/	T_08
ECO_MASTER_GAMMA	Ecophon Master™ Gamma	SGE	http://www.ecophon.com/en/products/Modular-ceilings/Master/	T_08
ECO_SOLO	Ecophon Solo™	SGE	http://www.ecophon.com/en/products/Tree-hanging-units-and-baffles/Solo/	AC_10, G_01, G_02, K_10, K_15, MB_03, OA_02, T_01, T_05, T_08

Figure 5. The identification interface of the relation between the products existing in the market and design rules

Companies Interface where the companies which are the producers or suppliers of the products described in this interface and companies which are the publishers of reference that publications is also accessible from the Opening Interface (Figure 6).

Firm ID	Title	Type	Web	Address	Phone	Fax	E_mail
SGE	Saint-Gobain Ecophon	Manufacturer	http://www.ecophon.com/	Saint-Gobain Ecophon AB Box 500 SE 265 03 Hyllinge Sweden	+46 42 17 99 00	+46 42 22 59 29	
T&F	Taylor and Francis	Publisher	http://www.taylorandfrancis.c				

Figure 6. Identification and Monitoring Interface of Producer/Supplier/Publisher Companies

Another interface which can be accessed through the Opening Interface is the Support Information Interface which is accessible to the following data sets:

- Design Rule Classes List (Figure 7)
- Design Rules Class Levels List (Figure 8)
- Phase List of Design Rules (Figure 9)
- List of Authors (Figure 10)
- Keywords List (Figure 11)
- Design Rules Visual Object Types List (Figure 12)

ID	Level	Definition
	GENERAL	All Items
A	COMPONENT	Lighting elements
AÇ	SPACE	Open office
AK	COMPONENT	Accessories
B	COMPONENT	Separating elements
C	SPACE	Cubicle
D	COMPONENT	Floors
DU	COMPONENT	Walls
F	SPACE	Photocopy and printer
G	SPACE	Entrance/Reception

Figure 7. Identification and monitoring interface of Design Class Rules List

LEVEL ID	Phase ID
COMPONENT	DESIGN
GENERAL	PRE_DESIGN
SPACE	DESIGN

Figure 8. Identification and monitoring interface for levels related to Design Rule Classes (space/component)

PHASE ID
DESIGN
PRE_DESIGN

Figure 9. Identification and monitoring interface of the phases of the Class of Design Rules

Author ID	Surname	Name
AUT_000	Available	Not
AUT_002	Kring Herbert	R.
AUT_003	Aknesil	Erdem
AUT_004	Acar	B.
AUT_005	Bradley	J.S.

Figure 10. Identification and monitoring interface of the authors of the publications



Figure 11. Identification and monitoring interface of keywords



Figure 12. Identification and monitoring interface of visual objects types associated with design rules

Finally, graphic type of reports obtained by making numerical analysis via transmitted data to the system can be accessed from the Reporting Interface (Figure 13 and Figure 14).

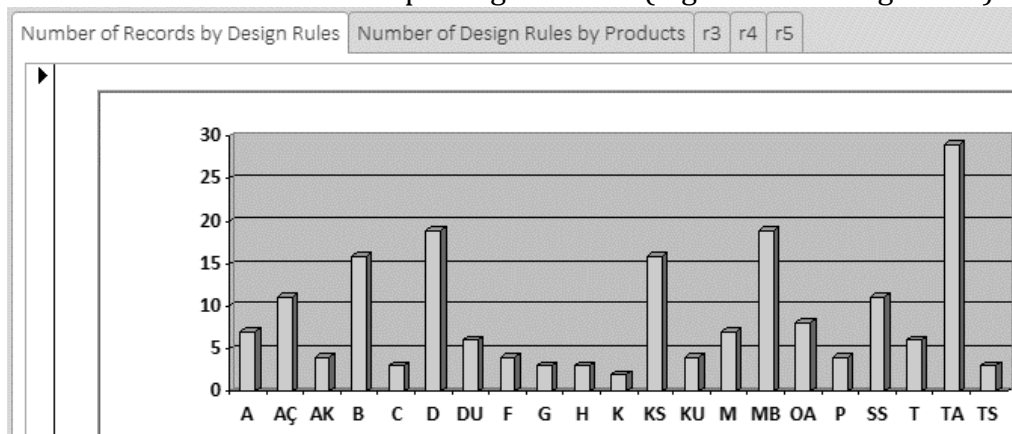


Figure 13. Graph of recorded numbers based on Design Class Rules

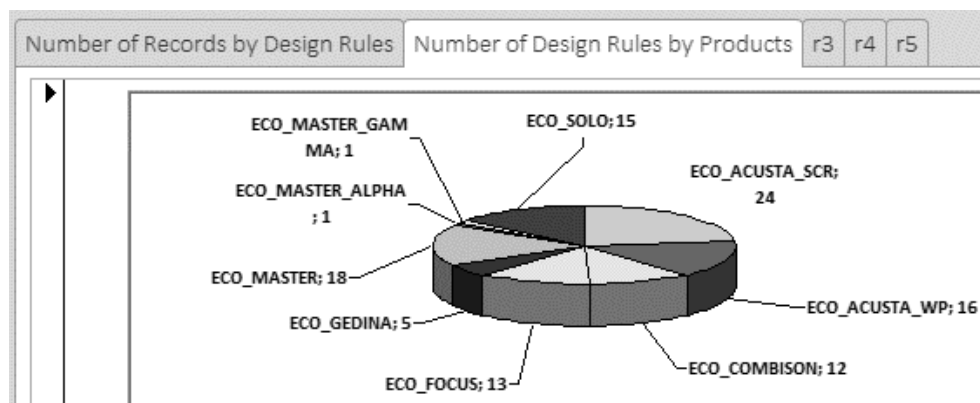


Figure 14. Graph of the number of Design Rules on the basis of products

RESULTS

Design rules in the literature created as a result of various scientific studies for increasing interior design success in terms of acoustic comfort in open-plan offices will be reached by virtue of this database. In addition access will be provided to information related to products or materials needed in the application phase of the design rules in the database and which are sold in the sector. In other words, it will be able to be seen which design rule can be performed with which material or product and company information related to them will be able to be accessed.

When the database is used by academics making researches in the field of acoustic all the scientific studies made on acoustic comfort in open-plan offices will be reached by virtue of a specific systematic and it will be able to be observed the subjects on which there is and on which there is not intensity.

Companies working in the field of acoustic in the sector will be able to follow the scientific studies which have been made as to the product or material within the sales range thereof thanks to the database and use them in their product R & D works.

In addition, numerous different statistical results such as graphic of registration on the basis of design rule classes, number of design rules on the basis of products, will be able to be obtained thanks to the proposed database model. Such results will be able to be employed for different purposes in both academic and sectoral levels.

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