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MODEL OF KNOWLEDGE-INTENSIVE PROCESS FOR ESTIMATION OF COST OF PRISON WORKS IN BRAZIL

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ABSTRACT

The research has as its product the modeling of the intensive process of knowledge of the parametric estimation, called expedite (fast) and parametric (because it uses the parameters of the project and/or work) to be used to model the costs of services (foundations, superstructure, cladding, facilities, etc.) of undertakings for the purpose of incarceration: prisons, prisons, prisons, juvenile prisons and jails. The research aims to provide the model of the estimation process with recommendations for cost professionals to build their estimates. For the execution of this model, the samples came from 39 enterprises for use as juvenile prisons in a Brazilian state. The logic of the estimation process model can be reproduced for the other kinds of prisons mentioned above. The parametric estimation requires a multidisciplinary team; and there is a risk of not representing in the equations the real cost of services, when not all variables that influence costs are considered. Choosing the drivers proves to be one of the most delicate steps of the estimation.

KEYWORDS: Process management, knowledge-intensive process, parametric estimation, prison works.

1. INTRODUCTION

Brazil ranks 4th among the world's countries with the largest prison population. (INTERNATIONAL CENTRE FOR PRISON STUDIES, 2014). About 7.4% of the Brazilian prison population is composed of young people under the age of 18, distributed in 350 prisons for this use in the country. (BRASIL, 2012).

The U. S. Department of Defense (UNITED STATES OF AMERICA DEPARTMENT OF DEFENSE, 2011) demands, in the context of US government hiring, that the public administration is tasked with preparing cost estimates, thus positioning itself as a cautious contractor. The Brazilian Law No. 12.462 (BRASIL, 2011, art. 9), called The Differential Public Procurement Regime (RDC), states that: “The estimated value of the contract will be calculated based on the values practiced by the market, on the amounts paid by the public administration for in similar services and works or on the assessment of the overall cost of the work, measured by using a synthetic budget or expedited or parametric methodology”.

This research has as its product the modeling of the intensive process of knowledge of parametric or expedited (fast) parametric estimation (based on project or work parameters). For this research, the estimate is focused on the costs of services (foundations, superstructure, coatings, installations, etc.). Cost models refer to Brazilian juvenile prisons.

The article is part of an assignment of a doctoral discipline, where the modeling of the expeditious cost estimation process is developed, an estimation modality that has as premise the speed of response to the budget forecast for use in public administration, which bids and hires these works in Brazil.

The model aims to extract and explain the knowledge of the estimation process, which is not static, and was developed through the sample of data from the juvenile prison system of a Brazilian state, which is responsible for holding more than 50 % of young prisoners in the country.

It is expected, with the present research, to assist the public administration bidding and construction sectors with respect to the reproduction of parametric expedited estimates, aiming to create a model of the estimation process, since it enables the construction of cost equations that enable speed response in forecasting the costs of projects when there are no complete projects.

Equations, which are the products of the estimation process, apply directly to estimates, even when the public agent is not an expert in the area, as resource provisioning is often not necessarily calculated by the sectors responsible for the public administration constructions but by administrative sectors, which often frame prison projects according to the previously approved budget available. This justifies the need for equations via easy-to-apply estimation.

The article also aims to draw the attention of the academic community to the development of research involving prison enterprises in the country, which are little explored in academic research, but have great social relevance, due to the maintenance of public safety, and the necessity of housing the population serving a prison sentence in the country.

2. LITERATURE REVIEW

The literature review of this research summarizes, briefly, process management, knowledge-intensive process, parametric cost estimation, and juvenile prisons works in Brazil.

2.1 Process Management and Knowledge-Intensive Process

The concepts of Process Management and Knowledge Intensive Process (KIP) are important for both academia and the market and business, as they represent the ultimate source of competitive advantage. Increasingly, business processes are becoming dependent on the knowledge acquired by the people who realize it through the tasks and activities that compose it. (RICHTER VON HAGEN et al., 2005).

Davenport and Prusak (1998); Nonaka and Takeuchi (1995) distinguish knowledge as the fundamental resource and the most respectable productive factor in the conjuncture of organizations. Maldonado et al. (2008) mention that “Modeling knowledge-intensive processes presents an important challenge, as it serves to provide greater understanding and better management of the activities of the organization. [...] Thus, the processes that contain the greatest amount and quality of knowledge are fundamental to the achievement of the organization's objectives”. The authors further assert that the modeling of organizational processes poses a major challenge for the specialized areas, as they mean a coherent and logical way of exposing the organization's value stream and focusing on its activities that integrate greater value. (MALDONADO ET AL.,2008).

However, according to Melão and Pidd (2000), the difficulty of modeling processes brings the authors of this field a need to reach higher coefficients of efficiency and effectiveness between modeling and reality, and between what is being modeled and the reality that it is being modeled.

Maldonado (2008) understands KIP as a type of poorly structured process with a higher degree of dynamic complexity, which depends heavily on the tacit and the explicit knowledge present inserted in the players and tasks. KIPs have the following characteristics:

- They are sequences of activities and value co-optation dependent on the obtaining and the using of knowledge;
- They evolve as they are carried out, based on the knowledge obtained, and are characterized by poorly structured specifications; the flow of activity is dynamic;
- Human agents have an intense influence on the outcome of the process, with high unpredictability in the implementation of activities; process players have the ability to reuse and shape knowledge from other domains and different levels of expertise;
- The lifetime of the knowledge involved in the process is often short as it is constantly updated and often requires a long time to be obtained;
- KIPs do not follow structured working rules, and performance measures are complicated to set up and measure;
- The support by Information and Communication Technologies (ICT) to KIPs is not sophisticated, even though they rely heavily on socialization and informal knowledge exchange;
- In general, the costs associated with the management of KIPs and their outcomes are high.

Therefore, the objective of modeling KIPs is to identify the in-process knowledge requirements, then to assume and reuse them, in order to promote their representation and structuring. (MALDONADO, 2008).

Wielinga (2012) assures that in the last 25 years knowledge modeling is being an underestimated method, though an important way to reduce the complexity problems that arise in building knowledge-based applications.

2.2 Parametric Cost Estimation

Public works cost management encompasses all activities that ensure that the enterprises are completed within the stipulated budgets. (TCU, 2006). Construction costs are interpreted as the amount of resources employed, resulting from disbursements with services, capital, or financial operations, indispensable for the carrying out of an enterprise in all its stages, from the feasibility study, over a determined period of time. (ANDRADE AND SOUZA, 2003).

Parametric estimation is modeling that uses parameters; it is used to forecast construction costs using data from previous projects. (SONMEZ, 2008; JI ET AL., 2010). Cerea and Premoli (2010), on the other hand, say that the parametric estimation or parametric modeling is expressed through an analytical function inserted in a set of variables.

Projects have unique characteristics that should be considered in cost estimates. However, information related to the scope of the project is most likely to change in the early stages. In view of this, the estimator should rely on strategies, considering, in the estimation, the minimum scope information or, preferably, those that do not undergo constant changes. (JI ET AL., 2010). According to NASA (2015), there is also a barrier to achieving the expected performance in the production routine, due to unforeseen events related to the resources and the scheduling of the production process.

NASA (2015) mentions that cost estimates present two types of uncertainties that may impair accuracy: one of them is related to the problems existing in the employed method, resulting from the omission of cost variables, poor specification of coefficients, and poor mathematical relationships, besides the lack or inconsistency of the historical data used.

2.3 Construction of juvenile prisons in Brazil

Public works are "all constructions, renovations, manufacturing, restoration, or expansion, carried out by direct or indirect execution" (Art. 6, item I of Brazilian Law No. 8.666/1993). Works of juvenile prisons – the buildings that provided the data for the elaboration of the model for the estimation process of this research – are funded exclusively by the public administration in Brazil, and each State of the Brazilian Federation builds, maintains and operates them.

Juvenile prisons are intended for young people over 12 and under 21 years of age. They have functions very different from other kinds of prisons, jails, penitentiaries, and temporary detention centers: these ones house male and female prison population over 21 years of age in Brazil.

Using the Brazilian Law on Access to Information, the newspaper Carta Capital (2014) published that, among the 148 custody units that were part of the socio-educational system of the State of São Paulo in 2014 (largest state in population and wealth in the country), 54% were overcrowded.

The legal website JusBrasil (2012) revealed that, in the State of Minas Gerais, only the young perpetrators of serious crimes were admitted in the 22 state custody units. Young suspects of homicide, armed robbery and rape relied on the system's inability to receive them to serve their sentences, and the State's detention facilities were overcrowded by 48.7% in 2012.

According to the Ricmais news website (2015), the state of Santa Catarina had only 29 custody units in 2015, and 627 young people were waiting, in freedom, for vacancies to serve their socio-educational sentences.

The juvenile prison buildings usually have dormitories (cells), multi-sport courts, classrooms, medical and psychosocial care rooms, professional training rooms and libraries. These spaces are part of the security of the unit; whereas kitchen, laundry and unit management rooms are separate, for security management purposes. The photo in Figure 1 shows the entrance to one of the dormitory wings of a juvenile prison.

Figure 1: Interior of a Juvenile Prison (source: Carta Capital, 2017).

The units are surrounded by at least two layers of security walls and ramparts (the latter, more than 6 meters high), and also have other security devices such as concertinas (arranged on the top of the walls), nets with anti-escape meshes (with cutting edges) above the walls, and walls plated with flat and/or cutting plates, and other devices to make difficult climbing and escaping the units.

Brazilian juvenile prisons are smaller than penitentiaries (on average they house 2,000 inmates). The older Brazilian units, prior to 2006, do not follow this model, having layout and capacity similar to the penitentiaries, but this model fell in disuse in Brazil.

Figures 2, 3, 4 and 5 present a summary of the current layouts of these buildings. For security purposes and at the request of the project provider, the building details, as well as of the walls, ramparts and sentry boxes have been erased in the drawings since they follow a standard security layout and their full publication is not allowed.

The size of the units built from 2006 onwards ranges from 2,000 m² to 6,000 m². Units prior to this date may reach more than 10,000 m². The change in the size of the buildings aimed at increasing the number of units, so that the young people could serve their sentences near their families or their city of origin. There was also an effort to humanize these spaces with a view to the recovery of inmates and their resocialization.

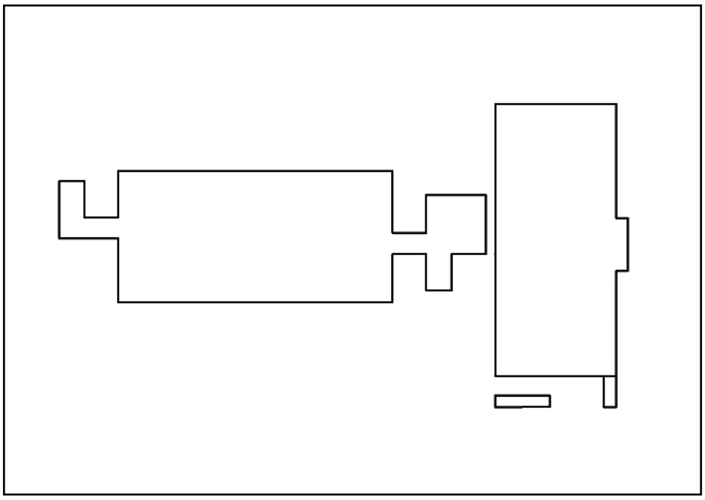

Figure 2: Example of blueprint of a juvenile prison (source: Isaton, 2016).

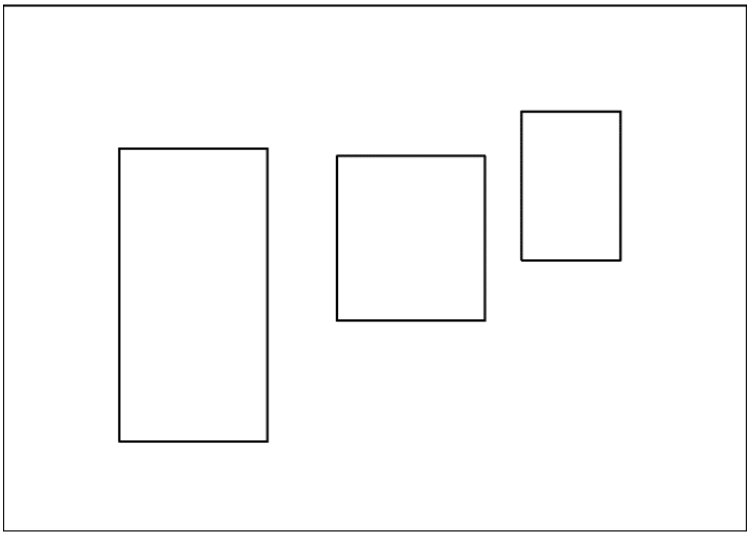

Figure 3: Example of blueprint of a juvenile prison (source: Isaton, 2016).

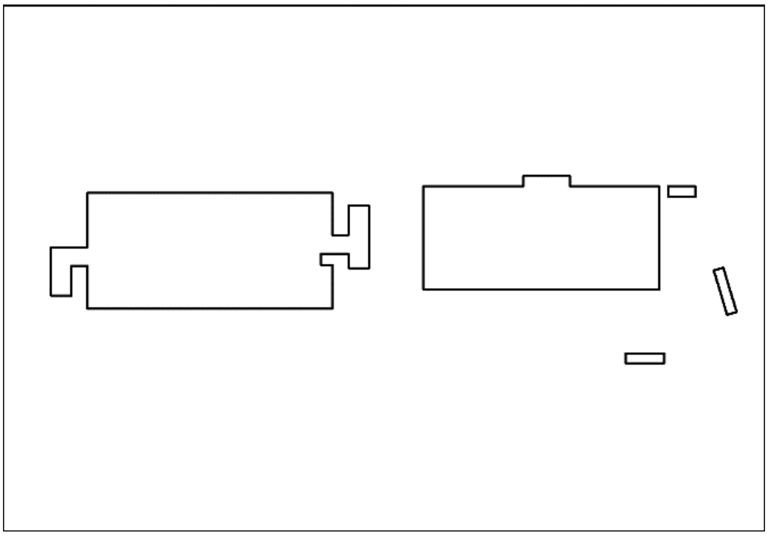

Figure 4: Example of blueprint of a juvenile prison (source: Isaton, 2016).

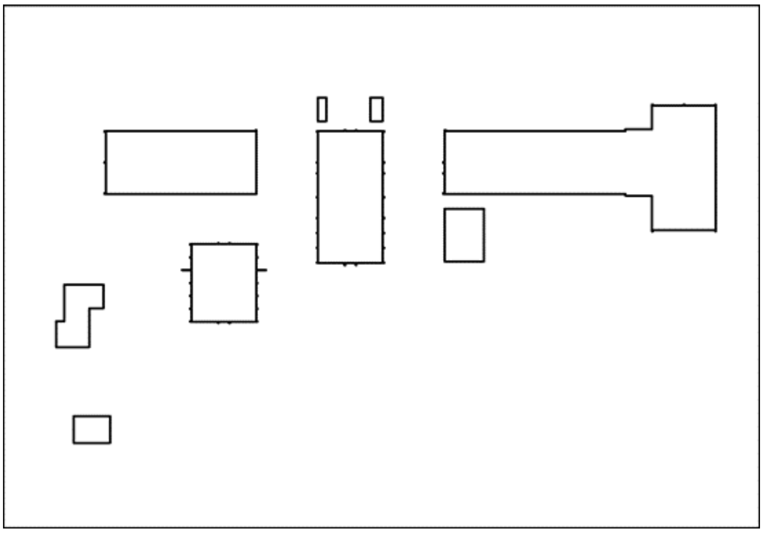

Figure 5: Example of blueprint of a juvenile prison (source: Isaton, 2016).

Prior to the creation of the Brazilian Child and Adolescent Statute (ECA), Brazil went through several stages and changes regarding the evolution of care policies for this public. Before the Statute, for example, there was no distinction between underprivileged children and underage offenders. (FUNDAÇÃO CASA, 2010). With the emergence of the ECA in the 1990s, the Brazilian Doctrine of Integral Protection was born. (FUNDAÇÃO CASA, 2010). From that moment on, children and adolescents are assured of their rights, declared as a legal priority.

In 2006, the Brazilian socio-educational system is marked by the publication of the National Socio-Educational Service System (SINASE), launched by the Special Secretariat of Human Rights of the Presidency of the Republic in partnership with the National Socio-Educational Council. (SINASE, 2012).

The publication of SINASE has led to positive changes in the system that receives minors in all states of Brazil, since after its publication the states are required to invest in socio-educational policies. In the context of the juvenile prisons, efforts for the construction and revitalization of buildings are initiated in accordance with the guidelines recommended by law.

For instance, the State Council for the Rights of Children and Adolescents of the State of Santa Catarina warned of the need to comply with the ECA and the SINASE, justifying the need for investments in the sector – that so far has not been able to receive the young people already tried – aiming at the achievement of crime reduction in the state. (RICMAIS, 2015).

3. METHOD

This research aims to provide the estimation process model, with recommendations for cost professionals to build their estimates. The logic of the estimation process model can be reproduced in other prison enterprises, such as temporary detention centers, jails, semi-confinement units, and female and/or male penitentiaries.

To perform the estimation equations, which is the final product of the estimate, detailed budgets, descriptive memorials, measurements, and other documentation of works, which we will call sample information, are required. The enterprise is treated similarly to a patient history, where the enterprise design and other information needs to be retrieved in as much detail as possible, as all of this information will form the database.

It is recommended to gather information on a considerable number of enterprises with characteristics that allow them to be grouped. Over 30 projects are recommended when working with costs at a global level, and this number can be reduced and the more punctual is the necessary estimation of costs, for example, at the level of one service, input or place of project implementation, this number may be reduced.

The variables for the development of the cost analysis through parameterization become data, and these are taken from the samples (enterprises and/or buildings) through project readings, detailed budget partitioning, and the checking of work diaries and descriptive memorials. The partitioning of information is a judicious and non-static job, and depends on what the estimation client requires.

All the documents that make up the samples (juvenile prisons already built) that provided the data were elaborated by the agency that builds the juvenile prisons, which also maintains the units after their completion, being responsible for the conception of the designs, estimations, budgets, descriptive memorials, contract documents and other technical documentation.

The agent responsible for making the expedite cost estimation needs to get the proper information from design architects, construction engineers, people responsible for the bidding process, and responsible for the system of conditioning of resources, as the kind of equations that will be provided depends on this information. This ranges from the most general equations (which show the global costs), which make it possible to know the total cost of a juvenile prison less than 15 min of applying the equations, up to the specific equations by cost of service, cost of environment to be built, or cost per juvenile prison location.

To begin the elaboration of the equations for the parametric estimation, the data standardization is the first step, which precedes the entering of these data into the modeling software chosen by the estimator. In this phase, the player responsible for the estimation starts the partitioning of the information on the works, which, depending on the time for the delivery of the equations, requires a team to analyze the information on the works since their conception.

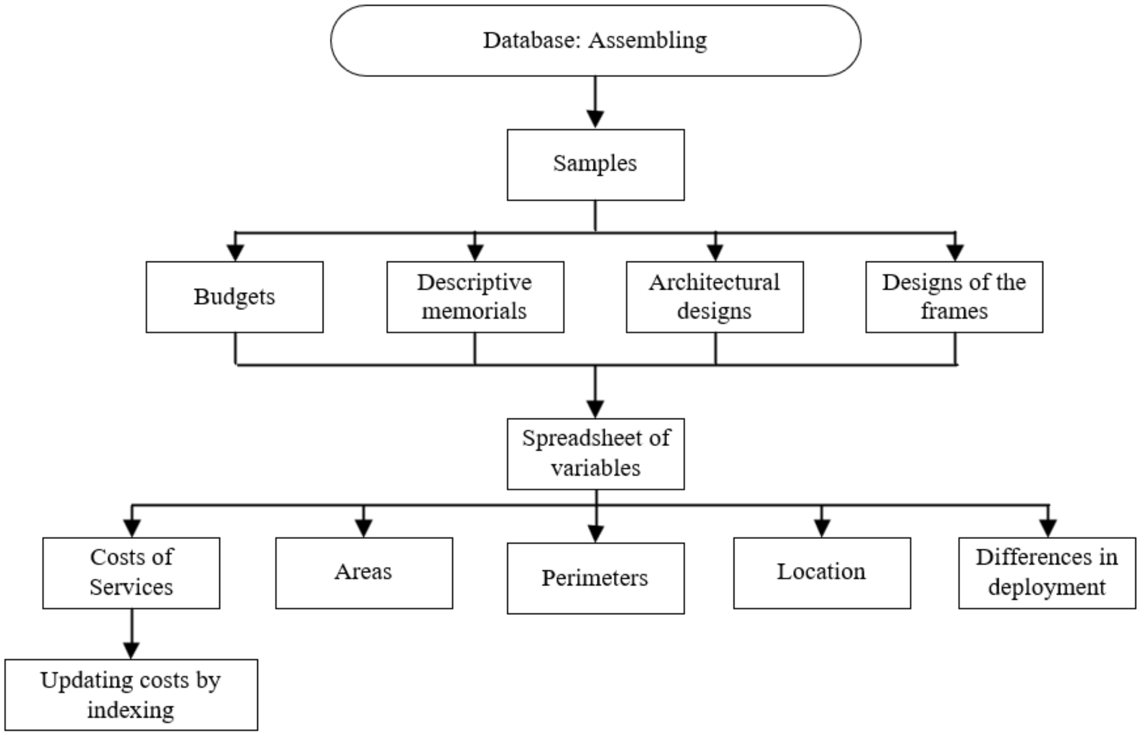

Figure 6: Schematic diagram of the information withdrawal from documentation and start of data assembly (source: Isaton, 2016).

Figure 6 shows how the parametric estimation process is started. Besides advanced statistical domain or other methodology, according to the estimator preferences, such as artificial neural networks, Bayesian statistics and other techniques, the estimator needs to identify the variables that will be used, always in accordance with the response needs of the organization that needs the equations for use in cost estimates.

Figure 7 works with the costs of services (such as structures, coatings, foundations, etc.). To accomplish this, the mapping of the total effective areas of the prisons, their internal and external perimeters, their location (since this directly influences the cost, and they are grouped according to their regions) and differences of implementation (for example, if implemented in cities with available public systems of water supply and sewage collection services, or if it is built in a rural area where their water supply and sewage treatment systems will be individual and self-sufficient, and thus must be built to meet the needs of the new unit).

The indexing of costs and their update to the current date is a very important step, because if it is not performed, it will not reflect the resources at the current date that the services that make up the works require. This step should be redone every month to update the equations.

For the carrying out of the parametric estimation, the data can be organized using the Excel® software. In Figure 7, it is exposed how to start collecting information from the projects and descriptive memorials. This will assist in the organization of the data that will be taken from the samples.

The samples were organized and numbered in the first column of Figure 7. The other columns show the date of construction of the buildings and also important details that influence costs, such as the sharing of the sewage treatment system between 1, 2 or 3 custody units.

The general characterization of the enterprises is presented in the fifth column of Figure 7. This is how the buildings are classified, whether compact (one-story, two-story or three-story buildings) or ground floor units, for example. It is important to classify whether the building is for female or male use, since in women's penitentiary units there are, for example, babies nurseries, daycare centers and differentiated cells with cradles for nursing mothers, i.e., it is important to classify according to the usual nomenclature of the type of institution with which the estimator is working, in order to facilitate the application of the equations by the professionals who will use them.

NOTES	UNIT NAME	YEAR	ENTERPRISE	TYPOLOGY
1	1	2006	Single	Compact
2a	2	2010	Single	Compact
1	3	2013	In an existing compound	Compact
Ground floor	4	2013	In an existing compound	Ground floor
3?	5	2006	Shares infrastructure	Compact
3?	6	2006	Infrastructure shared with Unit 5	Compact
2a	7	2006	Triplet	Compact
2a	8	2006	Triplet	Compact
2a	9	2006	Triplet	Compact
X	10	2007	Shares infrastructure	Compact
X	11	2007	Shares infrastructure	Compact
2	12	2006	Shares infrastructure	Compact
2	13	2006	Shares infrastructure	Compact
1 ou 2a?	14	2012	Shares infrastructure	Compact
1 ou 2a?	15	2012	Shares infrastructure	Compact
Ground floor	16	2006	Single	Ground floor
2	17	2006	Single	Compact
2	18	2009	Shares infrastructure	Compact
2	19	2009	Shares infrastructure	Compact
2	20	2007	Single	Compact
2p?	21	2012	Shares infrastructure	Compact

Figure 7: Example of Initial Database Assembly (source: Isaton, 2016).

The independent variables of the estimation equations can be geometric parameters such as: areas, perimeters, or even number of floors, number of security cages, number of wings, bathrooms, dining rooms, coordination rooms, etc., which can be organized as suggested above in Figure 7.

The measuring units should always be accurately defined: for example, in an estimation, the safety steel can have its cost equation in kg (kilograms) or in m², depending on the dynamics of the works sector and the applicability of the equations.

In Figure 8, each item has a number for the organization and systematization of the information. The organization is simple, and it is emphasized that it changes according to the purpose of the estimation, as well as according to the volume of data to be organized and analyzed. For the construction of the model, 39 enterprises were used out of a total of 46 available for the assembly of the database, an information volume of 60 gigabytes.

					1	2	3	4	5	6
UNIT NAME	YEAR	ENTERPRISE	TYPOLOGY	CONSTRUCTIVE SYSTEM	TOTAL AREA OF THE UNIT	AREA OF A CONSECUTIVE FLOOR	AREA OF ADM.	AREA OF HEALTH AND NURSING	AREA OF WORKSHOPS AND CLASSROOMS	AREA OF SERVICES, KITCHEN AND LAUNDRY
1	2006	Single	Compact	Conventional	1,960.64	541.36	211.60	78.82	209.04	95.10
7	8	9	10	11	12	13	14	15	16	17
AREA OF REFECTORY	AREA OF SENTRY BOXES	AREA OF DORMS, MONITORS, LIBRAR	AREA OF STAIRS AND CAGES	AREA OF SPORTS COURT	TOTAL AREA OF CORRIDORS	TOTAL AREA OF SECURITY	TOTAL AREA OF SECURITY FRAMES	PERIMETER OF ADMINISTRATION	VERTICAL AREA OF ADMINISTRATION	PERIMETER OF HEALTH AND NURSING
110.81	32.65	421.00	188.84	672.00	196.68	1,960.64	1,410.73	150.32	420.90	74.58
18	19	20	21	22	23	24	25	26	27	28
PERIMETER OF WORKSHOPS AND CLASSROOMS	VERTICAL AREA OF WORKSHOPS AND CLASSROOMS	PERIMETER OF SERVICES, KITCHEN AND LAUNDRY	VERTICAL AREA OF SERVICES, KITCHEN AND LAUNDRY	PERIMETER OF REFECTORY	VERTICAL AREA OF REFECTORY	PPERIMETER OF SENTRY BOXES AND GATEWAY	VERTICAL AREA OF SENTRY BOXES AND GATEWAY	PERIMETER OF DORMS, MONITORS, LIBRARY	VERTICAL AREA OF DORMS, MONITORS, LIBRARY	PERIMETER OF SPORTS COURT
108.56	320.25	70.49	197.37	66.76	196.94	34.60	96.88	257.50	759.63	118.30
29	30	31	1	2	3	4	5			
VERTICAL AREA OF SPORTS COURT	EXTERNAL PERIMETER OF THE UNIT	EXTERNAL PERIMETER OF ADM., KITCHEN AND LAUNDRY	COST OF PRELIMINARY SERVICES	COST OF FOUNDATIONS	COST OF SUPERSTRUCTURE	COST OF MASONRIES	COST OF SECURITY			
154.31	150.73	156.12	R$ 150,376.47	R$ 83,408.88	R$ 1,095,385.79	R$ 253,793.63	R$ 1,908,909.00			

Figure 8: Organizing the parameters of each enterprise (source: Isaton, 2016).

Each sample (prison enterprise) has its own spreadsheet such as a patient's chart, where all the information is organized, and then transferred to the general spreadsheet containing all the parameters of all the enterprises of the sampling, with parameters that will be the variables of the equations. An example of organization is shown in Figure 9.

	Structure								Masonry			
SAMPLE	Regular wood mold	Plywood flat mold	Total molds	Structural Steel CA 50	Structural Steel CA 60	Welded mesh armor	Total steel	Structural concrete	Apparent masonry 9 cm	Apparent masonry 14 cm	Apparent masonry 19 cm	Total masonry
	m^2	m^2	m^2	kg	kg	kg	kg	m^3	m^2	m^2	m^2	m^2
1	180.00	80.40	260.40	3,520.00	1,349.77	5,060.75	4,869.77	35.20	0.00	2,980.88	600.00	3,580.88
2	180.00	80.40	260.40	3,520.00	1,349.77	5,060.75	4,869.77	35.20	0.00	2,980.88	600.00	3,580.88
3	741.08	2,020.60	2,761.68	48,183.41	1,349.77	5,060.75	49,533.18	708.02	301.32	2,980.88	911.83	4,194.03
4	2,564.00	619.00	3,183,00	14,200.00	620.00	17,468.00	14,820.00	544.20	36.00	678.00	615.00	1,329.00

To be continued

Figure 9: Organizing the quantitative (source: Isaton, 2016).

The flowchart shown in Figure 10 complements the assembling of the database. In this step, each service group becomes a database with 39 enterprises and their parameters which are candidate to be independent variables. For the application in this research, were used the external perimeter, total area, internal perimeter, and others that had a strong correlation with the cost-dependent variable of the services that make up the project analytical structure and the scope of the enterprises.

As for the data relating to the costs of the service groups, they were normalized by indexing to a common date. In this survey the index used was the Brazilian National Civil Construction Index (INCC).

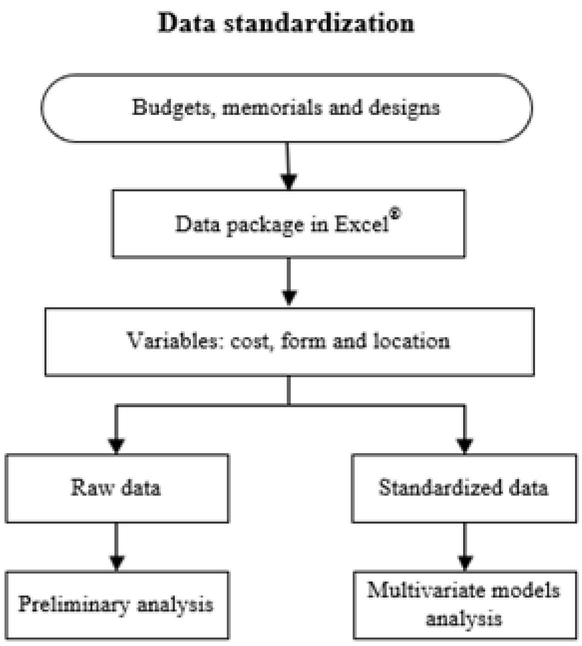

Figure 10: Data standardization (source: Isaton, 2016).

The drivers established for this research were: total area, external perimeter and internal perimeter, which are defined according to the degree of correlation between them and the variable cost.

In residential and commercial works, for example, the total area frequently is strongly correlated to costs, but for prison works this changes, and it is verified that the perimeters have a higher correlation. One of the possible causes is the high cost of the prison frames (bars), because they are made of high-performance safety steel, thus, the more internal walls there are, i. e., the more compartmentalized is the prison (compactness index), the higher is its cost.

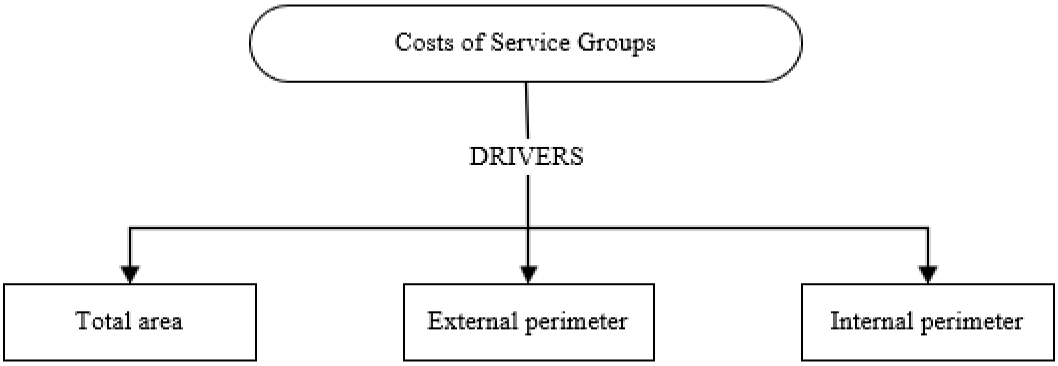

Figure 11: Drivers for the Service Groups (source: Isaton, 2016).

4. RESULTS AND DISCUSSION

Figure 12 shows an example of a group of services to be analyzed, one of the services that make up the scope of the enterprise. It is up to the player responsible for the estimation, in partnership with the planning engineer and the production engineer of the construction site, to gather the activities that make up a macro-service to be estimated. As can be seen, the security frames service includes the installation of bars, security bars used in prisons, monitoring displays, handrails, access cages and other items that are executed by the construction locksmith's team.

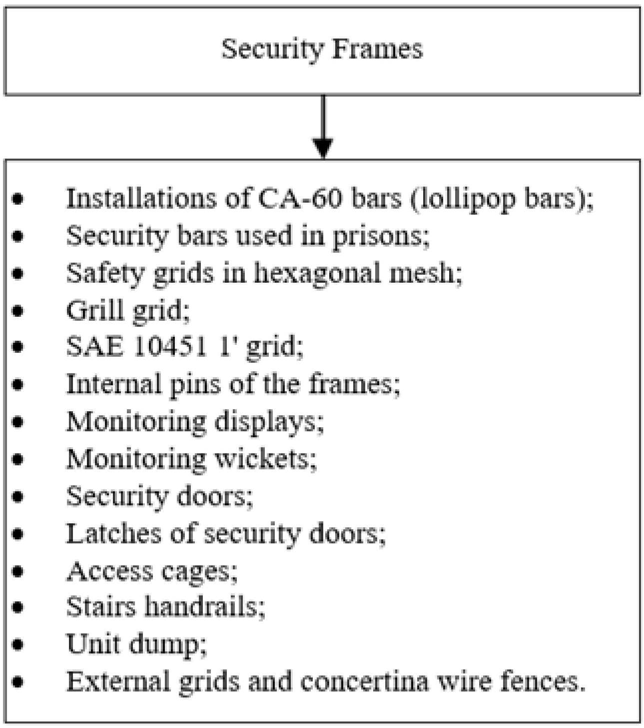

Figure 12: Security Frames Service (source: Isaton, 2016).

The basic rule in parametric modeling is to start from the simplest up to the most complex, in order to check the trends and behaviors of the data set, including assembling and grouping the service under analysis, and its correlation with costs. At the end of the modeling, the equations to be used in the estimations are delivered to the client. As an example, we present Equation 1, relating to the Security Frames Service shown in Figure 12:

$$CESEG = 43{,}328.75 + 77.40 * PE + 264.40 * PI + 33.60 * AT$$

Where:

CESEG: Costs of security frames

PE: External perimeter

PI: Internal perimeter

AT: Total area

This equation is applied using only the architectural design of the new prison, that is, it is not necessary the design of frames, which is elaborated after the basic design is approved, i. e., complex services were estimated in a simple way by dividing the total cost of the work by the total area, which brings considerable cost deviations, since complex services ended up having their costs decreased in this division, when treated in a similar way to a service of lower cost and lower risk.

Through the equation above, presented as an example, those responsible for the provision of resources can know what size of prison can be erected when the budget has costs as a restriction. The service presented as an example is the second most expensive of a prison work. It is classified as category A in the Services ABC Curve, and the equation presented makes the estimation within a 30% probability, plus or minus.

The estimation process model presented in Figure 13 describes the step-by-step process of constructing a cost estimate synthetically. The detailed breakdown of the steps is explained in the methodology of this article.

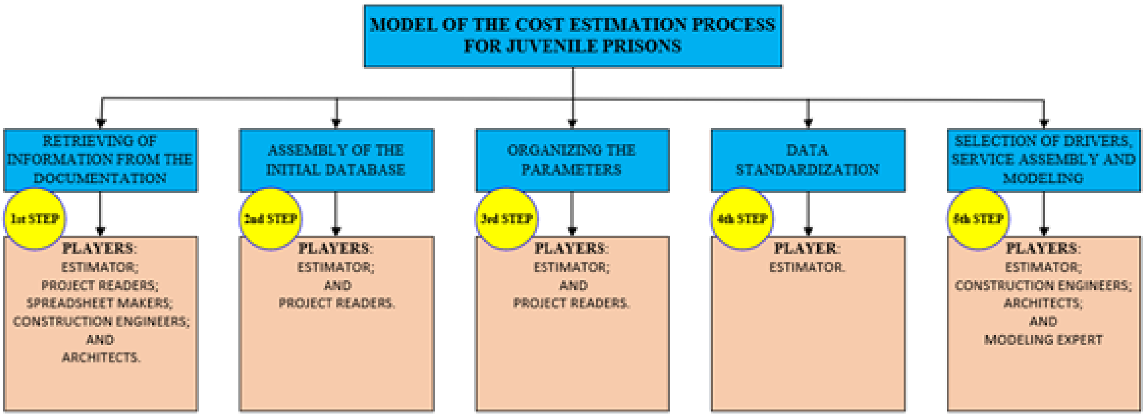

Figure 13: Cost Estimate Model (source: Prepared by the authors, 2019).

The estimation process is characterized as knowledge intensive because it is not static, predictable, and has variables that change according to the context where the estimate will be developed. It is correlated with the size, location, shape, geometric distribution of the prison, index of internal walls, and infrastructure of the place of implementation.

For buildings with the purpose of restricting freedom, the estimate is developed with a focus on the services that present the greatest risk to the executor (the company that wins the bidding). These are also analyzed by the public administration during the design phase of this kind of building.

5. CONCLUSION

This research provides as contribution the intensive knowledge model of the parametric cost estimation process presented in figure 13 (results and discussions). This model shows the processes that make up the estimate and the players involved, as well as the order for the activities that make up the parametric cost estimation for the construction of juvenile prisons buildings. Previous researches has approached the parametric estimation with the objective of producing cost models but have not presented the construction of the estimation here called knowledge model, which is applicable for future parametric estimates.

As shown in the model (Figure 13) the parametric estimation consists of a multidisciplinary team, considering the different profiles of the players involved. It is classified as a knowledge-intensive process because it presents activities that depend on the objective of the estimation. To achieve the global costs of the works services the quantitative are withdrawn and correlated with the costs to perform the service.

The first step of the model, presented in figure 13, addresses the removal of information from the work documentation. In this step we have as players: engineers, architects and project readers. This process unfolds in Figure 6, called the systematic of information withdrawal from the documentation and beginning of data assembly, that is, the model presents the suggestion of how to start the organization of the work data, as well as the services that compose it and will be estimated in the parametric estimate.

The second step of the model, called initial database assembly, has as its players the estimator and the project readers. This activity is explained in detail in Figure 7, where the initial database assembly is exemplified.

The third step (organizing the parameters) presents the estimators and the project readers as players. The activity is presented in detail in figure 8 and organizes the parameters of each of the enterprises. At this stage it is recommended to know which parameters will be analyzed, for example, total area, internal and external perimeters, location of the project, finishing patterns etc. From this choice, the data are organized according to the objectives of the parametric estimate. Figure 9 (organizing the quantitative) is also part of this stage, because to perform multiple linear regression it is necessary that the parameters are organized in unit with the respective quantitative values, which correlate in the linear regression with the parameters, whether these are the amount of building material, or amount of labor, or amount of service (labor with material).

The fourth step of the process deals with the data standardization, where we have as player the estimator, the professional who will build the equations or cost models. At this stage, with the spreadsheets ready and the chosen parameters, the statistical treatment begins with the normalization of the data and the multivariate analysis, in order to test the correlation between the variables and the previously chosen parameters, so that the estimator choose the best adjustment for the cost equation.

The fifth step is the choice of cost drivers, service assembly and modeling, and it has as players engineers, estimator, architect etc. Figure 11 presents the choice of cost drivers as the total area, the inner perimeter and the outer perimeter. The assembly of the service is shown in Figure 12, where we have the safety frame service. At this stage it is up to the professional to gather all similar elements to compose the service. When modeling, the selection of the dependent variable is based on the objective of the estimate, which is to quickly know the cost from some easily accessible parameter at the beginning of projects. In this research, the cost of safety frames is the objective of the estimate, that is, it is the dependent variable, having as independent variables the total area, the outer perimeter and the inner perimeter, information available before the frame design and which make it possible to assume the cost of this service before the budgeting phase (deterministic method).

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