



Environment Systems: A New Concept on Cremation

Claudio Decker Junior^{*1}, Emerson C. L. Muniz², Nicholas J. Cruz³

¹Production Engineering Department, Santa Catarina State University, Rua Paulo Malschitzki 200,
University Campus Avelino Marcante, 89219-710, Joinville, SC, Brazil

e-mail: claudiodecker@gmail.com

²Production Engineering Department, Federal University of Sergipe, Avenida Marechal Rondon,
Rosa Elze, 49100-000, São Cristovão, SE, Brazil

e-mail: eng.prod.emerson@gmail.com

³Faculty of Economics, Administration and Accounting, Federal University of Alagoas, Campus A. C.
Simões, Avenida Lourival Melo Mota, Tabuleiro do Martins, 57072-970, Maceió, AL, Brazil

e-mail: admnickolas@gmail.com

Cite as: Decker Junior, C., Muniz, E. C. L., Cruz, N. J., Environment Systems: A New Concept on Cremation,
J. sustain. dev. energy water environ. syst., 6(2), pp 363-380, 2018, DOI: <https://doi.org/10.13044/j.sdewes.d5.0190>

ABSTRACT

The pollution generated by cemeteries and their overload are increasingly worrisome issues in current society, and yet there are few studies seeking to discuss and generate solutions in this field to provide better lives to the population. Thus, this research has aimed to develop a new concept of a cremation service called “Mobile Crematorium”, aiming at innovation and an alternative for reducing impacts caused by cemeteries. Hence, a new model of service development was used, jointly with bibliographic research, semi-structured interviews with entrepreneurs and questionnaires answered by the population to collect essential information. Thus, requirements, needs and specifications of the clients and the service were developed, jointly with an analysis, simulation and selection of alternative solutions generated that allowed the creation of the new concept. Finally, the service process was modelled on the “Service Blueprint”, allowing visualization and identification of possible process failures and improvements thereon.

KEYWORDS

Cremation, Environmental management, Mobile crematorium, Service development, Service operations management, Sustainable development.

INTRODUCTION

For ancient folks, the remains of people were considered sacred and conservation of the same was a natural practice, so the burial process was one of the first manifestations of this feeling as a tribute to the remains of loved ones [1]. The habit of burying the dead has been going on since pre-history, however, cemeteries were only implemented by Christians [2].

The term cemetery began to be employed in the Middle Ages, when the dead began to be buried in cemeteries within villages and burials were conducted inside churches, monasteries and surrounding areas [3, 4].

* Corresponding author

The majority of studies on environmental impacts caused by cemeteries have been performed in Brazil, where they, along with sewers, septic tanks, landfills, industrial activities, storage, and fuel distribution centres [5], among others [3, 6] are the major anthropogenic sources of pollution in urban areas. Most studies have not been carried out overtly on cemeteries, as they only present analysis on internal and external decomposition [7]. And currently, most municipal cemeteries encounter difficulties in resolving their funeral problems. One can see clear-cut neglect in cemeteries in a great number of towns and cities [8, 3].

Pollution from cemeteries occurs silently and continuously and at the beginning of the 21st century, it was included in the lists of traditional sources of environmental contamination [8]. However, there are few studies defining cemeteries as an object for environmental study in academic surroundings, as it is a rather delicate issue due to factors, such as cultural beliefs and issues linked to the phenomenon of death.

Considering this and a number of glitches that took place regarding funerary constructions, collection of mortuary fees, constructions of perpetual cemetery plots and inspection of developments and funeral services, the National Environmental Council [Conselho Nacional do Meio Ambiente (CONAMA)], created the CONAMA Resolution #335 dated April 23rd 2003. This document defines regulations for compliance of cemeteries, to minimize the effects from environmental contamination on nature and population.

One of these is leachate, a viscous and dense liquid [1,230 kg/m³] that is rich in salt minerals, brings about a strong odour and results in a high biochemical oxygen demand, penetrates into groundwater, and spreads a range of diseases to the population [9]. Other factors are the residues from chemotherapy treatments, cosmetics, dyes and stiffeners (used in corpse preparation and makeup), pathogens associated to deaths from infectious contagious diseases and metal oxides such as Titanium (Ti), Chromium (Cr) and Cadmium (Cd) [3, 8, 9].

There are also organic compounds in areas surrounding cemeteries [10], high electrical conductivity, alkalinity and soil hardness, due to the presence of nitrogen and phosphorus compounds and various salts [8]. In addition to these factors and according to Brazilian Institute of Geography and Statistics homepage, there is still a high number of deaths annually registered in Brazil, about 1,148,165, increasingly contributing to the reduction in the ability of cemeteries to prevent this, especially municipal ones (<http://www.ibge.org.br>).

For these reasons, cremation has been an important mechanism in the elimination of viruses, germs and bacteria, helping to improve sanitary conditions for mankind. The fact is, this procedure reduces the body to dust through intensive heat and evaporation, resulting in decomposition, as the body is composed of 75% liquid and 25% solids (flesh and bones). Thus, the liquid part evaporates and becomes gas, so only the dust is left arising from the solid portion [1].

But despite this, cremation is a process that impacts the environment as well. The Polychlorinated Dibenzo-p-dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) emitted by crematories [11-14] have become a serious problem in many countries due to their toxic effects and health implications. The impact from the cremation process and its dioxin emission on the environment is still an incipient study [15].

However, the number of studies on the potential risks derived from crematorium emissions is small, and even non-existent, for some factors such as Nitrogen dioxide (NO₂), Carbon monoxide (CO), Sulfur dioxide (SO₂) and Polycyclic Aromatic Hydrocarbons (PAHs). Due to the growth and spread of the cremation process, crematories should also be among those facilities whose emissions should be specifically regulated and audited [15].

It is necessary to find ways to reduce these impacts to the environment based on the above information, as this is a key issue for the survival of the general population. Thus, this article aims to develop a new service concept related to the cremation process, called “Mobile Crematorium”. This aims to contribute to reducing damage caused to the environment due to the burial of bodies. Indeed, many Brazilian cities need this type of service, because it will be impossible to store corpses in the future, especially in municipal cemeteries.

ADOPTED METHODOLOGY IN THIS RESEARCH

For the development of a new concept and service modelling process, the model displayed in Figure 1 was used, focusing mainly on the stages of ‘concept design’ and ‘service process’ [11].

There are three macrophases in this model composed of two phases in each, where each macrophase features a particular purpose. The first seeks to identify everyone involved in the project and promotes articulation of their respective needs and expectations as objectives for the system. The second seeks to identify a proposed service to deliver the maximum value to involved parties. And finally, all the promises and expectations of customers have to be met [16].

Within the service concept design, initially a literature search was performed in the following databases: Scopus, Web of Science, ScienceDirect and SciELO, a thesis database and dissertations, and information on the funeral industrial sector was conducted, aiming to put researchers in direct contact with what was available and published [17].

In order to assess customers’ needs, unstructured interviews were also performed with businessmen in this sector from the states of Santa Catarina, Sergipe, Alagoas and São Paulo, as well as bibliographic research was also done. Similarly, a semi-structured questionnaire was filled out by the population and 230 responses were obtained.

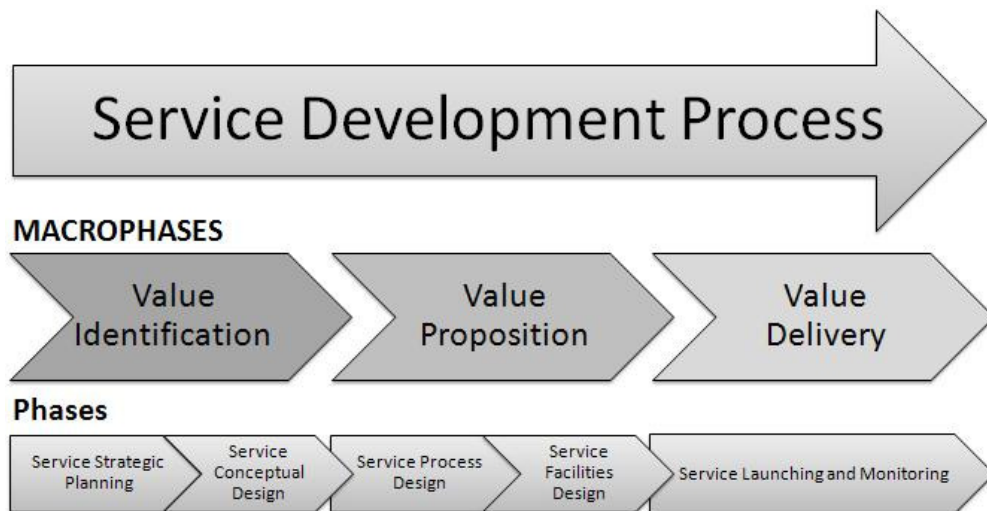


Figure 1. Service development process model

Then to help in transforming the needs into service requirements (technical characteristics the service must perform in order to meet customers’ needs), the Mudge Diagram was utilized.

Thus to generate service specifications, the Quality Function Deployment (QFD) was applied that is an efficient approach for dealing with the voice of the customers and their needs [18, 19]. This can be considered as an innovative management tool structured by matrices representing the relationships between characteristics of products and services

in the “Quality house” format [20]. As well as identifying and capturing what the customer wants (Customer Voice) or needs and the way to achieve those needs. Therefore, QFD should be employed throughout the service development process for the purpose of providing support and incorporating the actual needs of customers in providing the service [21].

The functional decomposition method was applied through the specifications, aiming at outlining the entire service structure and identifying any existing point of failure in it. Then, the morphological method was applied, a systematic method of creativity employing a structured approach for the generation of alternative solutions for the service [22].

In order to select the best alternative of generated solution, the research applied the Pugh Matrix. That is the most practical, fastest and most suitable for filtering unfeasible concepts for developing products and services. It provides a way to analyse the ability of concepts to meet the evaluation criteria through a comparison to an alternative reference, using customers’ needs as the evaluation criteria [23, 24].

Following that, developing the service concept, the research work was based on the four elements presented by Johnston and Clark [25] which must be contained in the service statement concept: elements on the service experience, results from delivering services, service operation and prices for services.

After that, the “Service process design” phase began, using it for the Service Blueprint modelling method. Thereby, this represents every step of the delivery process of a service, identifying all activities from the Front and Back Offices in a schematic and detailed manner. They are separated by the “Line of visibility” making it possible to clearly identify which processes are visible or not to customers [26-28].

The Service Blueprint can then be seen as a tool of communication among all clients, i.e., those who consume and provide the service [27]. Thus, it presents a collaborative visualization among stakeholders in the service. Another point worth mentioning is the fact that it helps simplify the complexity while showing the operation as a system, allowing visualization of the role of each component for providing the service [29].

SERVICE CONCEPTUAL DESIGN

In this section the conceptual design of the service will be presented.

Information search

Cremation is an ancient ritualistic procedure that nowadays has displayed as an option with increasing demand. It started being performed in São Paulo, Brazil in the 1970s and only became more popular in the late 1990s, expanding thereafter throughout Brazil. Although, there are still some difficulties in performing this service, as this takes place especially in rural Brazilian cities.

Currently, cremation is gaining more market space, due to the lack of space in Brazilian cemeteries, especially in public cemeteries and this is an alternative mechanism for reducing contamination of the environment. Therefore, the possibility arises for creating and expanding a mobile cremation service provided to a specific investor public. This occurs by considering the related technical complexity and the possibility of providing support to future business initiatives specifically geared to cremation service activities.

Due to this, we have sought to further understand issues related to cemeteries and crematories in various media, such as: reports, articles (journals and conferences), treatises, dissertations, theses, and unstructured interviews with entrepreneurs in the sector. Only information geared to traditional cremation services was identified (performed at the company facilities), and public and private cemeteries are currently the locations most commonly used by Brazilians.

Thereby, the development project was confirmed, as being something totally new regarding human cremation and providing this service, as somewhat similar service was detected, however, that was focused on pet (animal) cremation on the European scenario. Through these interviews with entrepreneurs in the states of Santa Catarina, Alagoas, Sergipe and São Paulo, important information was shared on laws, maintenance expenses, analysis of future scenarios for growth of both services, prices for contracting services, among other information were obtained and used for making progress on this project.

An exploratory study using a semi-structured questionnaire was also applied, yielding a total of 230 responses, mostly from the states of Santa Catarina, Sergipe and Alagoas. It revealed that 63% of respondents are interested in the cremation process, expressing the main reasons as: this process causes a reduced environmental impact (26.3%), provides the possibility of placing remains where one wishes (18.7%) and avoiding any maintenance expenses (4.5%).

A variation of price ranges have been noted as 19.7% of the sample is willing to pay USD 212.00 for the service, 15.6% USD 213.00 to USD 425.00 and 12.3% USD 1,064.00 to USD 1,276.00. Regarding the location for cremation, 39.4% of respondents have opted for the crematorium premises itself and 21.7% other specific locations.

Finally, regarding the possibility of contracting the service, one of the issues displayed an average of 3.01 and a standard deviation of 1.45. Thus, there is no real positive or negative positioning for contracting the service, considering that the data points to a zone of balanced information, showing a great deal of variation thereof.

Defining customer needs

Campos *et al.* [25] highlight how important it is to know the way to exactly define the real customers' needs, and for this activity and a number of different approaches that can be used. Thus, by applying the selected methods and the above information, a total of 21 customer needs was met, as stated on Table 1.

Table 1. List of customer needs

| No. | Customer needs |
|-----|---|
| 1 | Providing an affordable price |
| 2 | Providing fast commercial services |
| 3 | Being ethical in delivering services |
| 4 | Providing agility in cremation services |
| 5 | Providing a beautiful urn |
| 6 | Showing a picture on the urn |
| 7 | Printing a name on the urn |
| 8 | Providing a hygienic process |
| 9 | Not releasing any smell |
| 10 | Providing a 24-hour service |
| 11 | Providing an easy payment service |
| 12 | Providing low maintenance costs |
| 13 | Providing a quiet cremation process |
| 14 | Qualified employees providing services |
| 15 | Promoting the service |
| 16 | Compliance with legislation |
| 17 | Providing a safe cremation process |
| 18 | Providing reliable services |
| 19 | Providing safe transportation |
| 20 | Providing effective transportation |
| 21 | Being transportable |

In order to analyse and assign prices to meet customer needs, as well as contributing to the generation of service requirements, the Mudge Diagram was utilized. It displays the needs of customers allocated in rows and columns and then it compares item by item. Thus, one can identify the percentage to show which needs are most important for the generation of service requirements [24].

Defining service requirements

Provide a list of needs and their prices, based on the Mudge Diagram, the service requirements were generated based on Table 2. These, in turn, can be understood as amenable technical features to measurement or not, considering the fact that the project is dealing with the intangible part of the service, so its performance and perception as viewed by customers [24].

Table 2. List of service requirements

| No. | Service requirements |
|-----|---|
| 1 | Service acquisition cost |
| 2 | Cremation noise level |
| 3 | Average initial service time |
| 4 | Number of advertising methods |
| 5 | Comply with environmental legislation |
| 6 | Number of internal surveys |
| 7 | Customer satisfaction % |
| 8 | Number of customer complaints |
| 9 | Answered calls % |
| 10 | Number of payment options |
| 11 | Number of training hours for employees |
| 12 | Container size |
| 13 | Container capacity |
| 14 | Meeting labour Standards |
| 15 | Feedbacks performed % |
| 16 | Number of truck maintenance procedures needed |
| 17 | Number of employees |
| 18 | Being ethical |
| 19 | No odours released |
| 20 | Quantity of maintenance equipment needed |

The most significant customer needs and requirements were considered up to then, as having direct relationship to customer satisfaction. According to the Mudge Diagram, the most important needs were related to the presence of a qualified staff, cremation process safety and compliance with laws. The next step focuses on surveying the service specifications, which is a delicate activity and not very easy to structure, as obtaining this information is crucial to the development process. They are a crucial part of the service, as they determine how the service will be created and how this will meet the customers' needs [30].

Defining service design specifications

As a first QFD step to obtain specifications, the first "Quality house" was structured. One can see the relationship between the generated needs and requirements from this.

Table 3 lists the obtained specifications, their units, targets and some observations. Some specifications have no units because some of these are qualitative characteristics, such as the specifications “being ethical” and “meeting environmental legislation”. However, they should not be disregarded from the project, considering they were generated based on customer needs and they can contribute to generating the service concept.

Table 3. List of specifications

| Requirement | Unit | Objective | Comments |
|---|---------|---|---|
| % Customer satisfaction | [%] | ≥ 95% | The customer satisfaction analysis will be performed directly with customers through satisfaction questionnaires ten (10) days after concluding the service |
| Number of customer complaints | # | ≤ 5% | Total number of complaints collected from the website, phones and satisfaction questionnaires related to the total number of services provided |
| Number of training hours for employees | [hours] | 2 hours/month | Through training verifications on improvements through other indicators and a staff assessment on training |
| Comply with environmental legislation | - | Compliance with all current legislation | Internal audits are used to ensure that all laws are being complied with and prevent surveillance audits and thereby suspend service providing |
| Meeting labour standards | - | Comply with all regulatory standards | The company will ensure compliance with all Regulatory Standards regarding safety and occupational medicine |
| Number of required truck maintenance procedures | # | Provide all necessary maintenance | Keeping all vehicle maintenance needs updated as stated in each user manual |
| Number of internal surveys | # | 1 survey/week | An audit will take place in all involved sectors in the service |
| Service acquisition cost | USD | ≤ USD 1,489.00 | The purchase price was estimated based on research in permanent crematories, cemeteries and customers |
| Being ethical | - | - | Through training all staff, always emphasize the importance of ethics our services provided |
| Number of employees | # | ≤ 10 | Analyse demand for making adjustments in the cost of the payroll, regarding profits |
| Number of payment options | # | ≤ 4 | Payment can be made by payment booklets, credit card /debit card, cash or checks |
| Average initial service time | [min] | ≤ 15 | This is just an average and will not be a productivity limiter or an evaluation criterion |
| Cremation noise level | [dB] | ≤ 65 | The service aims not to emit loud noises, and by default, if they occur, the values are stipulated by Regulatory Standard 17 |
| % Answered calls | [%] | ≥ 98% | Ratio between the number of answered calls and the total calls received |
| No odour emissions | - | - | - |
| Size of the trunk | - | - | - |
| Semi-truck trailer body capacity | [ton] | ≤ 45 | The largest sized vehicle can carry that carries the maximum load of up to 45 tons [maximum permissible drivable load by National Department of Transport Infrastructure (DNIT)] this refers to the semi-truck trailer body |
| Number of advertising means | # | ≤ 5 | Disclosures may be made by means of television, newspapers, billboards, internet, magazines, brochures, etc. |
| Number of equipment maintenance needs | # | Comply with all provided maintenance | Keep all equipment maintenance needs up-to-date according to the user manual |

Defining the functional service structure

Functional process mapping has been applied to the service aiming at minimizing its complexity and to express the inherent functions in the process. Figure 4 shows the six major functions, as well as their relevant activity on each one. This facilitated the step for generating possible alternatives for each activity based on the morphological method, whereas alternative solution were generated for each of the functions presented in Figure 4.

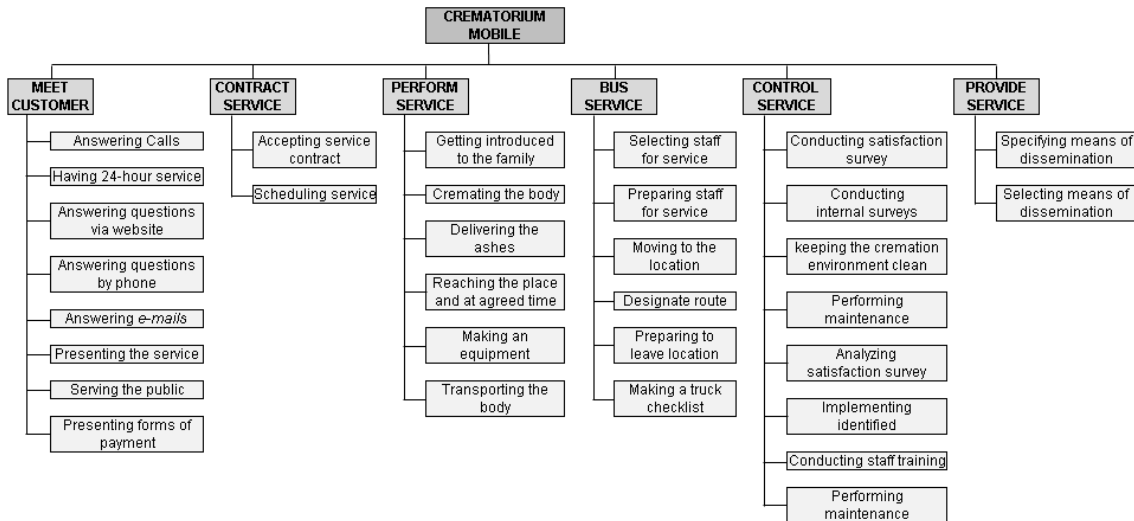


Figure 4. Functional service process mapping

Thus, a simulation and organization of these principles was performed, using the most diverse ways possible, aiming at generating a total of seven alternative solutions.

Alternative solutions:

- The service will be performed by a receptionist, working 24 hour shifts and the main customer questions can be answered by phone, as well as closing contracts and service scheduling, as well as making credit card payments. Cremations will be performed by trained personnel, divided into work schedules, transporting the body to the truck by a cart and ashes will be delivered in an urn. The crematorium is transported by truck and optimally routed and mapped by GPS. The maintenance of equipment and truck will adhere closely to their user manuals. Inspections, courses, surveys and improvement implementations are done by company teams. Finally, the service will be published by printed communication publications (newspapers, brochures and magazines);
- The service will be performed by vendors, working on a shift basis, answering questions by online chats, closing contracts and/or scheduling cremation by phone. The payment will be made through payment booklets. Trained staff will trace the arrival route of the equipment to the customer, using maps. They will carry the coffin to the machine and manually perform the cremation, and place the ashes in an urn. After concluded, the equipment will be sanitized and the truck will go to the next destination. 10 days after the procedure, satisfaction questionnaires will be conducted with the clients served, so service improvements can be implemented. Finally, the service will be publicized on television media;
- The service is provided by one of our partners, together with an attendant on 24 hour shifts and doubts can be resolved on the website and email. The seller may also personally provide, contract and schedule the service with customers, and check payments are accepted. Crematorium will be accompanied by a truck with

employees, planning the route through maps. The coffin will be manually transported from the site to the crematorium and the ashes will be delivered in a sealed urn. The maintenance of equipment and truck will adhere closely to their user manuals and inspections will be performed. Training for safe operation and improvements will be performed by external consultants. Finally, the service will be published on advertiser websites, emails and company homepages;

- The initial service will be conducted electronically, then a 24 hour on-call salesperson will be available to answer questions, close contracts and/or schedule services in person, and check payments are accepted. The scheduled staff plan the arrival route by GPS, after that they meet the family and carry the crematorium coffin on a cart. After cremation, the ashes will be delivered in a sealed urn. The maintenance of equipment and truck will adhere closely to their user manuals, and training and inspections will be conducted by external consultants. The identified improvements will be implemented by company employees. Finally, the service will be published on the company homepage and television media;
- The service is conducted 24 hours and initially on the internet. Then, a scheduled seller will answer questions by phone or via email. Contracting, scheduling and payments may be made by credit card on the phone. The truck and crematorium will be operated and conducted by trained and scheduled staff, and they use maps to trace the arrival route. After meeting the family, they carry the coffin on a cart to the crematorium and deliver the ashes in a sealed urn. The truck and equipment maintenance will be performed as stated in their user manuals for safety purposes. Internal surveys and training will be carried out by external consultants, as improvements will be implemented by the company team. Finally, the publication of services will take place on the homepage and printed publications;
- The service is available 24 hour work shifts by vendors, providing, scheduling and contracting services on-site or by online chat and payment by credit card. The scheduled team will operate the service, plan the route, use GPS equipment and fill out checklists on spreadsheets. At the specified location, they will carry the coffin by cart and then deliver the ashes in a sealed urn to the family. 10 days after the cremation, questionnaires will be filled out by the family by telephone and analysed by an internal company team. However, training and courses will be performed by external consultants. Finally, the services will be published on the company webpage and email (to the email database);
- The service will be available 24 hours and a scheduled seller will be available for questions, close contracts and/or schedule services by phone, payments are accepted by credit card. Trained and scheduled employees will plan the route by GPS and carry the equipment in a truck. When they arrive, they will meet the family and carry the coffin to the crematorium using a cart, place the ashes in an urn and at the end of the process sanitize the equipment. Maintenance will be performed in strict adherence to user manuals for safety purposes and inspections will be performed by external consultants. 10 days after performing the service, a satisfaction questionnaire will be conducted with the family by phone that will help to diagnose and improve process implementation. The employees are constantly trained for increased qualifications by holding internal training courses and finally the service is published on television media.

Only one of these alternatives was selected as a guide in developing the concept. Therefore, they were analysed by Pugh Matrix, whereas one alternative is chosen as the reference standard and then all are compared to each other, so the best one is selected. These results are shown in Table 4.

Thus, alternative 7 was chosen as a reference standard, and it also displayed the best results. However, in searching for improved results, "Providing 24 hour services" and

“Providing qualified employees” criteria were noted as showing lower results. Soon, these factors were retested compared to others in order to generate an appropriate concept.

Table 4. Pugh Matrix

| Customer needs | | Weight | Alternative solution | | | | | | |
|----------------|--------------------------------------|--------|----------------------|-----|-----|----|----|----|-----------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | Providing an affordable price | 5 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2 | Providing fast commercial service | 4 | -1 | -1 | -1 | 0 | 0 | -1 | |
| 3 | Being ethical in delivering services | 4 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 4 | Agility in cremation service | 5 | 0 | -1 | -1 | -1 | 0 | 0 | |
| 5 | Providing a beautiful urn | 4 | 0 | 0 | -1 | 0 | 0 | 0 | |
| 6 | Displaying a picture on the urn | 4 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 7 | Showing a name on the urn | 4 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 8 | Provide a hygienic process | 5 | -1 | 0 | -1 | -1 | -1 | 0 | |
| 9 | Not releasing odours in the air | 5 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 10 | Providing a 24 hour service | 5 | 1 | -1 | 0 | 0 | 1 | 1 | Reference |
| 11 | Providing easy payment methods | 5 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 12 | Having low maintenance costs | 4 | 0 | -1 | 0 | 0 | 0 | -1 | |
| 13 | Providing a quiet cremation process | 5 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 14 | Providing qualified employees | 5 | 0 | -1 | 1 | 1 | 1 | 0 | |
| 15 | Promoting the service | 5 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 16 | Compliance with the legislation | 5 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 17 | Providing a safe cremation process | 5 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 18 | Providing reliable services | 4 | 0 | 0 | -1 | 0 | -1 | 0 | |
| 19 | Providing safe transportation | 4 | 0 | -1 | 0 | 0 | 0 | 0 | |
| 20 | Providing effective transportation | 4 | 0 | -1 | -1 | 0 | -1 | 0 | |
| 21 | Transportable | 4 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Total + | | | 1 | 0 | 1 | 1 | 2 | 1 | 0 |
| Total - | | | 2 | 7 | 6 | 2 | 3 | 2 | 0 |
| Overall | | | -1 | -7 | -5 | -1 | -1 | -1 | 0 |
| Total weight | | | -4 | -31 | -21 | -5 | -3 | -3 | 0 |

Defining service concept

Developing the service concept is a key point to generating strategic advantage in developing services. From that, one can identify the value being delivered to the customer. However, the same, in essence, is currently based on the customer experience, making it increasingly intangible and continually increasing the difficulty in generating its concept, it is extremely necessary for the process [36]. Thus employing the use of these elements should be included in the concept, as explained in Johnston and Clark [25], who developed and called it “Mobile Crematorium” as shown below:

- The 24-hour service will be available through vendors working on shifts, for asking questions, closing contracts and/or schedule services by phone and getting credit card payments. The staff members perform cremation, working on shifts and transporting the equipment in a truck to a location specified by the customer, from the GPS mapped route. At the site, they will perform the service for family and carry the casket to the crematorium in a cart, handling the process conclusion and the ashes of the body in a sealed urn. They will perform the cleaning of all equipment and plan the route to the next destination. Aiming to maintain the safety of the entire process, maintenance of the truck and cremation equipment will be conducted strictly based on their technical user manuals. Internal

inspections are performed by external consultants in order to assure quality of processes. 10 days after performing the cremation, a telephone satisfaction questionnaire will be answered by the customer regarding the subjects identified as failures or suggestions for improvements. This information will be reviewed by the company to perform diagnostics and make improvements that will be implemented throughout the internal service staff. Focused on quality, all staff members will undergo qualification training and recycling conducted through lectures and courses taught by external consultants. Finally, regarding promoting services, this will be done by television and internet media (homepages and emails).

Based on this concept, we have sought to incorporate all elements, activities and processes necessary for effective operation of the services, ranging from activities of complete contact with the customer to internal processes that must be run and controlled. This will ensure quality and good service operations, as well as introducing an innovative concept to the academic scenario in this business sector and a way to combat contamination and pollution of the environment.

Innovation introduces something new to any activity. That means introducing something new or substantially modifying something ongoing [37]. Therefore, the purpose of this service is more related to the aspect of innovative services. This seeks to present an innovative concept and some novelty to the academic scenario.

Another innovative point in this project lies in its concern for the environment. The majority of academic research involving the funeral industry has analysed the situation and there have been few alternatives to solve or minimize environmental pollution [38]. This subject has become more prominent to the people in general, who have become more concerned about these environmental aspects, as noted in the results from questionnaires.

SERVICE PROCESS DESIGN

The following is the Service Blueprint model that sought to provide a framework for the entire process of the proposed service, as shown in Figure 5. The entire flow of information, people and materials involved in the process, as well as the points of contact between the customer and services could be seen and limited through a line of interaction and zones for dividing the execution of processes.

As seen in Figure 5, the visibility line is seen and the interaction zones have been well-defined, making the process more evident, clear-cut, and cohesive. This demonstrates a concern and carefulness for expressing all steps in service providing, yet not only limited to visualization but based on the service provider optics, but also from the customer's point of view. Especially in the steps regarding the decision on the progress of the services, that is their complete responsibility implying more active participation in the process.

In an analysis of the process, possible failure points were identified and expressed in the "Service Blueprint" in Figure 5, the following are some of them:

- Employee meets customer;
- The Staff plans the transportation route;
- The Employees deliver the ashes to the family;
- The Employees provide feedback on customer service;
- The Employees implement improvements, which were studied based on a review and analysis of specifications developed for the service, where customer satisfaction can be considered primary element.

And regarding these highlighted points, the employee element is noticeably present in all of them. Therefore, this is highlighted as a cornerstone to the success of the service,

and the proposed service development, presents convergence to the needs and expectations of customers obtained in the early development stages. Considering that, in the creation of previously presented alternative solutions, the training and qualification of employees variables were considered as extremely important to the smooth running of the process, as well as stated on all expressed alternatives.

Thus, approaches can be structured, whether it is by the client service or even by internal procedures, focused on the elimination of the presence of these failures points. It is important to observe the “Service Blueprint” can be constantly updated, so new failings can be observed and corrected, as being performed and thereby become increasingly robust and efficient processes, according to the specifications of the service.

And to conclude the discussions, it should be noted the costs for the services are still uncertain, because an analysis of the entire product-service system needs to be structured, as well as greater detail on the assembly and transport of this process. Thus, research has emphasized service providing to the population in general, taking into account the wishes and desires of customers. However, new features can be added to the service, always aiming to add more value to it, such as:

- Conducting ceremonies based on the customer’s religion;
- Housekeeping and embalming the body;
- Casket choices;
- Physical infrastructure, such as:
 - Chairs;
 - Tents;
 - Spaces;
 - Buffets for displaying the body before cremation, among other items.

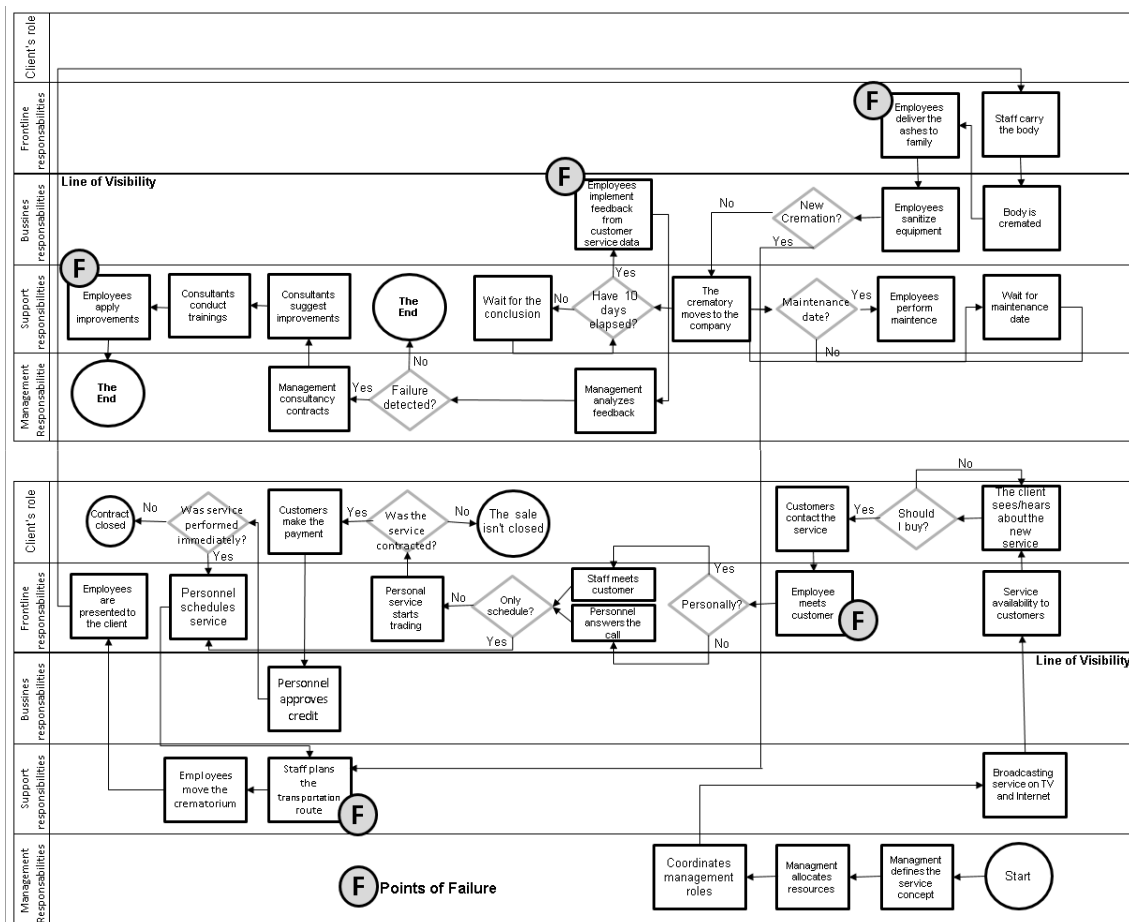


Figure 5. Modelling service by Service Blueprint method

CONCLUSIONS

It is still apparent that most cemeteries remain a major source of pollution in urban areas in Brazilian cities based on research, due to a number of factors caused by the decomposition of a human body. However, it has been observed that the use of crematories can be considered a viable and healthy option for the environment, due to the simple fact that this process causes much lower impact. Since bodies become dust as they are processed by evaporation at higher temperatures.

Considering this, a new service concept for cremation, called “Mobile Crematorium” was developed to contribute to the reduction of environmental impacts caused by the decomposition of bodies in soils. This has been accepted by the population and business community, demonstrating their proneness to contracting and investing in this type of service.

This project development can be seen as a paradigm shift within the funeral service market, firstly by taking an initial step in creating mobility in a stationary service that is still not widespread in Brazil. Secondly, because this is also another way to minimize problems currently seen in the Brazilian funeral scenario, as there is overloading and contamination of the environment through cemeteries, especially in municipal ones.

The development model used in the study was very valuable, because through it, the research followed sequential steps enabling the achievement of its primary objectives. As, it employed tools in the field of product development, such as QFD, Pugh and Mudge Matrices, Morphological Method, Service Blueprint, as well as information collected from the population, which are aligned to the goals of this project and have contributed to generating results.

According to the results, we have noted that the main points of the project abide in the pursuit and constant concern for customer satisfaction and care for the environment. Thus, they can be used as a guide for developing further research, such as the structuring of the product-service system, cost analysis and financial investments necessary for their full development. Primarily as a contribution to the business sector that has displayed interest in this new created idea.

Finally, it should be noted that the context of research involving death and/or its activities, mainly focused on finding solutions for the environment has still been discussed very little in the academic field. Thus, this work significantly contributes to the initial steps taken within this scenario and thereby demonstrating the propensity and lack of thematic displays. Therefore, continued studies need to be planned and carried out to go into greater depth on this concept, as the environment and the entire Brazilian population can only profit from new results. This will introduce environmental development to our country, and thereby seek to achieve the same results as developed countries, as those on the European continent, which are gradually doing away with traditional burial, in preference to cremation.

ACKNOWLEDGEMENT

The authors would like to acknowledge the National Council for Scientific and Technological Development (CNPq) for its financial support.

REFERENCES

1. Costa, A. C. S., Barros, C. E. C. and Pinto, P. A., Implementation of a Crematorium in Maceio: A Study of the Market Potential (in Portuguese), XXVII National Meeting of Production Engineering – ENEGEP, Foz do Iguaçu, Paraná, Brazil, 2007.
2. Silva, R. W. C. and Malagutti Filho, W., Cemeteries: Potential Sources of Contamination (in Portuguese), *Science Today Magazine*, Vol. 44, No. 263, pp 24-29, 2009.

3. Pacheco, A., Cemeteries and Environment, Sao Paulo (in Portuguese), *Ph.D. Thesis*, University of São Paulo, São Paulo, Brazil, 2000.
4. Klein, H. F., Monuments to the Memory of those who died: The Necropolis and its Environmental Impact (in Portuguese), University of Brasília, Brasília, Brazil, 2010.
5. Zychowski, J., Impact of Cemeteries on Groundwater Chemistry: A Review, *Catena*, Vol. 1, No. 93, pp 29-37, 2012, <https://doi.org/10.1016/j.catena.2012.01.009>
6. Feitosa, F. A. C. and Manoel Filho, J., *Hydrogeology: Concepts and Applications*, (2nd ed.) (in Portuguese), CPRM/REFO, LABHID-UFPE, Fortaleza, Ceará, Brazil, 2011.
7. Dent, B. B., Decay Products in Cemetery Ground Waters, Geology and Sustainable Development: Challenges for the Third Millennium, 31st International Geological Congress, Rio de Janeiro, Brazil, 2000.
8. Matos, B. A., Occurrence and Transport of Microorganisms in Groundwater Aquifer Cemetery Nova Cachoeirinha, São Paulo (in Portuguese), *Ph.D. Thesis*, University of São Paulo, São Paulo, São Paulo, Brazil, 2000.
9. Silva, L. M., Cemeteries in Environmental Issues (in Portuguese), SINCESP & ACEMBRA: Seminary National Cemetery and Environment, São Paulo, São Paulo, Brazil, 1995.
10. Zychowski, J., *The Effect of Mass Grave on the Content of Selected Organic Compounds in Groundwater* (Ziulkiewicz, M., ed.), State and Anthropogenic Changes in Water Quality in Poland, IV, pp 359-367, University of Lodz, Lodz, Poland, 2007.
11. Smith, T. O., Gitsham, P., Donell, S. T., Rose, D. and Hing, C. B., The Potential Dangers of Medical Devices with Current Cremation Practices, *European Geriatric Medicine*, Vol. 3, No. 2, pp 97-102, 2012, <https://doi.org/10.1016/j.eurger.2012.01.013>
12. Takeda, N., Takaoka, M., Oshita, K. and Eguchi, S., PCDD/DF and Co-planar PCB emissions from Crematories in Japan, *Chemosphere*, Vol. 98, pp 91-98, 2014, <https://doi.org/10.1016/j.chemosphere.2013.09.114>
13. Cheruiyot, N. K., Lee, W. J., Yan, P., Mwangi, J. K., Wang, L. C., Gao, X. and Chang-Chien, G. P., An overview of PCDD/F Inventories and Emission Factors from Stationary and Mobile Sources: What we know and what is missing, *Aerosol and Air Quality Research*, Vol. 16, No. 12, pp 2965-2988, 2016, <https://doi.org/10.4209/aaqr.2016.10.0447>
14. Xue, Y., Tian, H., Yan, J., Xiong, C., Pan, T., Nie, L. and Zhu, C., Present and Future Emissions of HAPs from Crematories in China, *Atmospheric Environment*, Vol. 124, Part A, pp 28-36, 2016, <https://doi.org/10.1016/j.atmosenv.2015.10.079>
15. Cruz, N. J. T., Lezana, A. G. R., Santos, P. C. F., Pinto, I. M. B. S., Zancan, C. and Souza, G. H. S., Environmental impacts caused by Cemeteries and Crematories, new Funeral Technologies and Preferences of the Northeastern and Southern Brazilian population as for the Funeral Process, *Environmental Science and Pollution Research International*, Vol. 24, No. 31, pp 1-14, 2017.
16. Forcellini, F. A., *Special Topics in Production Engineering: Development of Services* (Lecture Note) (in Portuguese), Graduate Program in Production Engineering – UFSC – Federal University of Santa Catarina, Florianópolis, Santa Catarina, Brazil, 2013.
17. Lakatos, E. M. and Marconi, M. A., *Fundamentals of Scientific Methodology* (5th ed.) (in Portuguese), Atlas, Sao Paulo, Brazil, 2007.
18. Akao, Y., *Quality Function Deployment: Integrating Customer Requirements into Product Design*, Tokyo: Productivity Press, Tokyo, Japan, 1990.
19. Chen, M., Lin, C., Tai, Y. and Lin, M., A Grey approach to the integrated Process of QFD and QE, *Concurrent Engineering*, Vol. 19, No. 1, pp 34-53, 2011, <https://doi.org/10.1177/1063293X11403507>

20. Lee, J. H., Phaal, R. and Lee, S., An integrated Service-device-technology Roadmap for Smart City development, *Technological Forecasting & Social Change*, Vol. 80, No. 2, pp 286-306, 2013, <https://doi.org/10.1016/j.techfore.2012.09.020>
21. Cardoso, A. A. and Ramos, G. V., Application of QFD for processing of Customer requirements in Quality Characteristics of banking Products and Services (in Portuguese), VIII Symposium for Excellence in Management and Technology, Resende, Rio de Janeiro, Brazil, 2011.
22. Rozenfeld, H., Forcellini, F. F., Amaral, D. C., Toledo, J. C., Silva, S. L., Alliprandini, D. H. and Scalice, R. K., *Management of Product Development* (1st ed.) (in Portuguese), São Paulo: Saraiva, Brazil, 2006.
23. Lu, W. F., Sun, J., Loh, H. T. and Chua, C. W., Concept Selection for Market Potencial using Fuzzy Selection approach, *Proceedings of the Industrial Engineering and Engineering Management*, IEEE – International Conference, Singapur, 2008.
24. Novaes, A. L. T., Development of a Mechanic for cleaning and sorting Oysters System (in Portuguese), *M.Sc. Thesis*, Federal University of Santa Catarina, Florianópolis, Santa Catarina, Brazil, 2005.
25. Johnston, R. and Clark, G., *Management of Service Operations* (in Portuguese), São Paulo: Atlas, São Paulo, Brazil, 2002.
26. Fitzsimmons, J. A. and Fitzsimmons, M. J., *Administration Services, Operations, Strategy and Information Technology* (6th ed.) (in Portuguese), Bookman, Porto Alegre, Brazil, 2010.
27. Spraragen, S. L. and Chan, C., Service Blueprinting: When Customer Satisfaction Numbers are not enough, International DMI Education Conference – Design Thinking: New challenges for Designers, Managers and Organizations, Cergy-Pointoise, France, 2008.
28. Bitner, M. J., Ostrom, A. M. and Morgan, F. N., Service Blueprinting: A Practical Technique for Service Innovation, Center for Services Leadership, Arizona State University, Arizona, USA, 2007.
29. Boughnim, N. and Yannou, B., Using Blueprinting method for development Product-service Systems, International Conference on Engineering design – ICED, Melbourne, Australia, 2005.
30. Mello, C. H. P., Turrone, J. B. and Silva, C. E. S., *Management Process of Service Development* (1st ed.) (in Portuguese), Atlas, Rio de Janeiro, Brazil, 2010.
31. Campos, J. L. G., Veiga, D. F., Rocha, L. R. M., Novo, N. F., Veiga-Filho, J. and Ferreira, L. M., Quality Function deployment in a Public Plastic Surgery Service in Brazil, *European Journal of Plastic Surgery*, Vol. 36, No. 8, pp 511-518, 2013, <https://doi.org/10.1007/s00238-013-0839-y>
32. Takeda, N., Takaoka, M., Fujiwara, T., Takeyama, H. and Eguchi, S., PCDDs/DFs emissions from Crematories in Japan, *Chemosphere*, Vol. 40, No. 6, pp 575-586, 2000, [https://doi.org/10.1016/S0045-6535\(99\)00232-5](https://doi.org/10.1016/S0045-6535(99)00232-5)
33. Machado, S., Environmental analysis of Cemeteries: A Current challenge for Public Administration (in Portuguese), *Journal of Human Sciences*, Vol. 6, No. 1, pp 127-144, 2006.
34. Camgoz-akdag, H., Tarim, M., Lonial, S. and Yatkin, A., QFD Application using SERVQUAL for Private Hospitals: A Case Study, *Leadership in Health Services*, Vol. 26, No. 3, pp 175-183, 2013, <https://doi.org/10.1108/LHS-02-2013-0007>
35. Halog, A., Schultmann, F. and Rentz, O., Using Quality Function deployment for Technique Selection for Optimum Environmental Performance improvement, *Journal of Cleaner Production*, Vol. 9, No. 5, pp 387-394, 2001, [https://doi.org/10.1016/S0959-6526\(00\)00080-9](https://doi.org/10.1016/S0959-6526(00)00080-9)
36. Fynes, B. and Lally, A. M., Innovation in Services: From Services Concepts to Service Experiences, Service Science, Management and Engineering Education for

- the 21st Century Service Science: Research and Innovations in the Service Economy, Vol. 3, pp 329-333, 2008, https://doi.org/10.1007/978-0-387-76578-5_48
37. OCDE, Guidelines for collecting and interpreting Innovation Data, Oslo Manual, 2005.
38. Mari, M. and Domingo, J. L., Toxic emissions from Crematories: A Review, *Environment International*, Vol. 36, No. 1, pp 131-137, 2010, <https://doi.org/10.1016/j.envint.2009.09.006>

Paper submitted: 01.08.2017
Paper revised: 31.10.2017
Paper accepted: 02.11.2017