

**Roadmap to implementation and management of innovation in the Brazilian civil construction industry.**

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# **ROADMAP TO IMPLEMENTATION AND MANAGEMENT OF INNOVATION: Brazilian civil construction industry.**

## **Introduction**

Civil construction is a key sector of the Brazilian economy that determines vectors of social development and indicates solutions to social, economic, and technical issues. Society has shown a growing need for habitation; therefore, a higher level of development of the national economy and the construction sector is required to meet this demand. Civil construction is a sector with specific characteristics that hinder the implementation of rationalized actions and technological innovations.

According to the Brazilian Chamber of Construction Industry - CBIC (2016), with the growth of the civil construction sector in Brazil, new companies entered the market thus promoting a considerable increase in competitiveness. This market growth, along with the dynamism and competitiveness in the business sector, has encouraged organizations to better the knowledge and capacity to adapt to new market trends (CBIC, 2016).

According to the Brazilian Association of Construction Materials Industry - ABRAMAT (2021), the civil construction sector accounted for roughly 6% of the Brazilian GDP in 2020. According to CBIC (2020), despite the economic downturn caused by the COVID-19 pandemic, civil construction was the sector that generated most jobs in Brazil, creating 138,409 formal jobs until October 2020, the best result for the sector since 2013.

Constant technological development and innovations have been transforming the environment and improving living conditions and it is not different in the civil construction sector. The use of innovative technologies, ecologically correct materials, energy-saving materials, information technology, and automated equipment is one of the most important trends in the modern construction industry.

Cavalcante (2019) states that innovation is not only the result of an idea but above all the action to make it effective and generate results for those and/or organizations involved. On the other hand, the implementation of innovations is not a simple task. On the contrary, it is a process of gradual, complex, and multicausal development, whose components of sweat and efforts are even greater than its geniality.

The civil construction sector faces specific barriers to the implementation and management of innovations, namely customer distrust in construction innovation, little government support, the predominance of small companies without the necessary resources for research and development, and the high cost of commissioning facilities (Pushkalova, 2019). Therefore, the roadmap is a tool that can help in this process.

Roadmapping has been applied and disseminated among organizations of different sizes, from small companies to large government policy projects. The aim is to achieve an effective alignment of strategic objectives of an organization with technologies related to products that are considered key elements for the success of businesses (Alcantara & Martens, 2018).

Many enterprises have used roadmapping. For instance, Motorola has used it for product development (Oliveira, 2009), studies on the Brazilian pre-salt layer (Borchevier & Lemos, 2016), the Lego Group for technology innovation and management (Kerr, Phall & Thams, 2017), and the construction sector for the implementation of total quality control (Cenk & Ukdan, 2022). However, the literature does not report roadmapping use for the implementation and management of innovation in companies in the civil construction sector.

Therefore, this study aimed to develop a specific roadmap for a construction company for the implementation and management of innovations. We also indicated some practical propositions to be implemented by companies in the civil construction sector and theoretical propositions for future studies.

## **1. Roadmap**

Roadmapping is a widely used tool for general planning and strategy management, promoting communication between the most diverse sectors of the organization (Lu, Chen & Yu, 2019).

For Martin, Ralf, and Phaal (2013), many managers are aware of the strategic importance of technology to generate value and competitive advantage for their companies, as the industrial networks in which they operate are becoming more critical in terms of cost, complexity, and technological innovation, which in turn increase competition while the sources of technology become global.

For Lu, Chen, and Yu (2019), companies use roadmapping to develop medium and long-term strategies to achieve business objectives, manage technical strategies, integrate technology and operations, develop technology at an enterprise level, to improve governance and practice, research, and development planning. In this sense, roadmapping has become a clear and organized way to present all the information obtained and consolidated in the process.

Figure 1 presents the generic roadmap in a time-based graph, comprising several normal layers that include commercial and technological perspectives (Gouvêa, 2009).

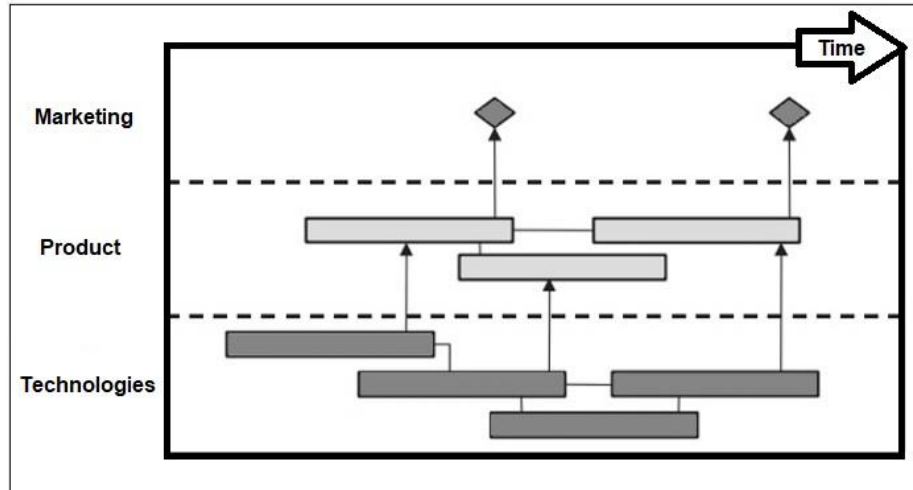


Figure 1: Generic roadmap

Phaal, Farrukh, and Probert (2001) present other roadmap models (Table 1), following their characteristic functions and main layers.

Table 1. Roadmap Templates

Name	Characteristic	Layers
Product roadmap	Associate the new aimed products and the technologies necessary for new products, which are defined in the strategic planning of the enterprise, and as new technologies that will be necessary to develop or incorporate that will give support to the development of the new products or processes over a determined time.	Product Technologies
Services and capabilities roadmap	The focus is to understand the influence of technologies on increasing capabilities to obtain a better flow in the company in compliance with trends pointed out by the marketing sector thus determining the events that will start and end the activities, determined in the planning workshops.	Events Marketing and, business trends Capabilities Technologies
Strategic planning roadmap	Presents the current state of the company in the aspects of marketing, business, products, skills, technologies, and organization, determining in the workshops the necessary activities within each of	Marketing Business Products Skills Technologies Organization

	these aspects over time to achieve the objectives outlined by the company.	
Long-term planning roadmap	Presents regional, national, and international information at the workshops to define the technologies needed and highlight the connections and their dependencies, to achieve the company's goals.	Goals
Roadmap for capacity and knowledge planning	Evaluates intellectual resources, processes related to knowledge, knowledge of managers, projects, and activities, listing at the workshops the activities that each aspect should perform over a given time.	Business goals Projects and activities Knowledge of facilitators Knowledge related to processes Intellectual resources.
Project roadmap	The flow of activities for each process is defined, the milestones that determine each phase of the project, as well as the specific moments for decision-making, in addition to the technological development that needs to accompany and meet the demands of the projects, expressed at the end of the roadmap.	Project Flow Significant points of the project Decision points Technological development
Process roadmap	Allows focusing on understanding how the flow of knowledge develops through the technical and marketing areas of the company over time thus allowing to organize within the workshops the preparation of each department to satisfy the demand of the project at the appropriate time.	Marketing prospects Processes for analysis Technical perspective
Integrative roadmap	Presents the definitions established in the workshops of the form and timing of how, throughout the project flow, the sectors participate in the activities required in the execution.	Components / subsystems / technologies Prototypes / Tests Systems / Technologies Systems in use

Borchiver & Lemos (2016) present four stages of the roadmapping processes (Figure 2).

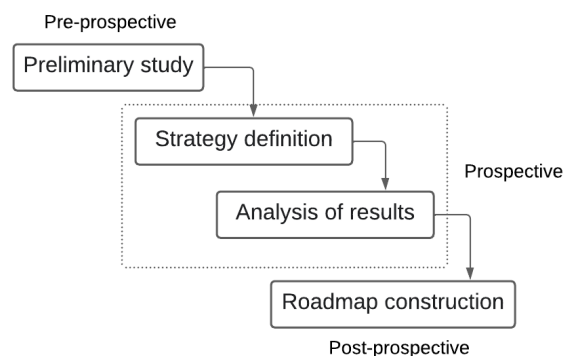


Figure 2: Roadmapping

In the pre-prospective stage, general information on the subject is collected without concerns about specific or scientific sources. It is the first contact of researchers with the material available.

In the prospective stage, information is collected in a guided way in scientific articles as well as documents referring to patents as a source of technological scientific information (Borchiver & Lemos, 2016).

## 2.1. Preparation Roadmap

For the implementation and management of innovation, two resources are necessary in addition to agile and unbureaucratic communication. One is the financial resources, as every step towards innovation generates costs and the company is responsible for establishing the limits for the financial resources available, which may come from the company's own budget, financing lines, public development initiatives, or partnerships with suppliers and customers. Another is the qualified human resources needed for the progress of the company's innovation projects.

Roadmap preparation establishes partnerships in which companies interact with the government and educational institutions, enhancing the power of implantation and management of innovation of each company. Partnerships can also be established directly with the different actors of the business model in which the company is inserted. Suppliers can assist with the information and necessary subsidies for innovation. Customers present the demand and generate financial resources thus increasing inputs and outputs and accelerating the innovation process (Docherty, 2006).

Figure 3 shows the Preparation Roadmap with the necessary steps for the subsequent realization of the Innovation Roadmapping, a process that generates the Innovation Roadmapping in Civil Construction. After defining the innovation objectives and a clear vision of its competitive advantage, the new business vision must be communicated to employees at all hierarchical levels, as well as to customers and suppliers. This allows to make all those involved aware of the changes that will occur within the company, providing channels for everyone to communicate in a simple and agile way thus facilitating the implementation of innovation.

Resources must also be provided thus it is necessary to delimit the investments that will be made and the people who will be responsible for managing the innovation roadmapping. After answering these questions, partnerships are sought with suppliers, customers, and educational institutions, mainly those that develop research thus collaborating with the company's needs.

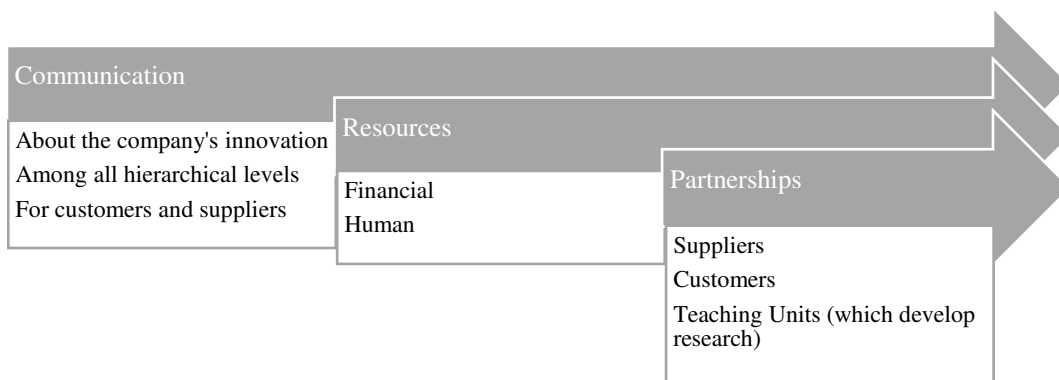


Figure 3. Preparation roadmap.

When the company's structure is already prepared for innovation, that is, it has fulfilled the phases proposed in the first phase of the roadmap (preparation), and the second phase of the roadmap (innovation) is applied.

## 2.2. Innovation roadmap

For innovation in civil construction companies, the second phase of the roadmap is divided into four areas according to the (PIT) Technological Innovation Program (2010), product innovation, process innovation, organizational innovation, and marketing innovation, proposing four stages of execution: scenario assessment, idea generation, planning and execution, and evaluation and feedback.

The steps proposed for innovation are repeated in all areas. The first of these steps is the scenario analysis and definition of objectives when the information contained in the strategic planning is selected according to each area of innovation and if additional information is needed to guide the process by defining its objectives.

The second stage, the selection of ideas (Figure 5) presents its specificities in each stage.

In the third stage of planning and execution, the ideas chosen in the previous stage are put into practice to be evaluated in the fourth and final stages.

At each stage, there is a validation phase (gate), as guided by Cooper & Sommer (2016), for managers to evaluate the projects in terms of sequence, rearrangement, or withdrawal.

Product innovation starts with the study of the consumer market to understand the demand and define the objectives to be pursued by the company thus recognizing its strengths and weaknesses (Tatum, 1987). After defining the objectives, a portfolio is created that will house the ideas generated and that are related to the objectives outlined. The ideas undergo a selection process, and the execution planning occurs for the selected ones, as in the model of Gosch (2016). Afterward, there is an evaluation by consumers and managers, feeding back the cycle. This process is part of the Civil Construction innovation roadmap (Figure 4).

	Pre workshop	Workshop		Post workshop
	Evaluation of scenarios and definition of objectives - gate	Selection of ideas - gate	Planning and execution - gate	Evaluation and feedback
Product	Market assessment	Selection of products that meet consumer demands	Planning and procurement	Assessment of the consumer market and company managers
Process	Assessment of available technologies	Selection of technologies that meet the objectives	Company workforce training Acquisition / deployment Development / implementation	Assessment of the company's Managers and employees
Organizational	Search for best practices	Selection of best practices	Decentralization of processes Expansion in communication	Assessment of the company's managers and employees
Marketing	Assessment of the company's and competitors' strategies	Selection of new marketing strategies Selection of new communication channels	Social media management Establishment of the learning strategy Generation of new communication channels: company / supplier / customer	Assessment of the company's managers

→ Time

Figure 4. Innovation Roadmap

Process innovation starts with the evaluation of new technologies available in the market, either through trade shows, the CBIC innovation catalog, or specialized and academic magazines, as suggested by Borchevier &

Lemos (2016), to choose the technologies that meet the company's needs and objectives. Afterward, the company trains its workforce by developing its employees, boosting innovation capabilities (TATUM, 1987). Defined by the acquisition of technologies for the new processes or their development by the company itself, the new processes are incorporated into the existing means of production and the employees responsible for the new processes evaluate the results thus feeding back the cycle of constant improvement (ISO, 2019).

Organizational innovation starts with the search for the best management practices to define the objectives to be followed, initiating an organizational change that may include expansion in communication, decentralization of processes, establishment of a training program for employees or other practices. These practices are then implemented with the evaluation of the results following the guidelines of ISO 56000 (2019).

Marketing innovation completed the four areas of innovation in civil construction with the evaluation of the scenario in which the company is inserted as well as the evaluation of its competitors, as proposed by Jonash & Sommerlatte (2001). Next, new marketing strategies are established that undergo media management, the establishment of the company's learning strategy based on customer feedback. There is also the generation of new communication channels between suppliers, the company, and customers with the assessment of the process by the company's managers, giving feedback to the cycle.

### 2.3. Roadmapping Execution

This study gathered points of convergence about the stages of roadmapping development, namely gathering information necessary for the process, whether through scientific material, such as articles in journals, or patent research, or by organizations dedicated to the area, such as CBIC, trade shows, and market research. There is also the definition of objectives and goals to be achieved in this process, the choice of human capital that will participate in the roadmap construction workshops as well as the construction of the roadmap and its constant evaluation and updating.

According to the literature and meeting the specifications of the civil construction industry, the following implementation roadmap is presented, which covers the proposals by Gouvêa *et al.* (2019) and Borchiver & Lemos (2016) and encompasses: preparation, information gathering, workshops, dissemination, and evaluation (Figure 5).

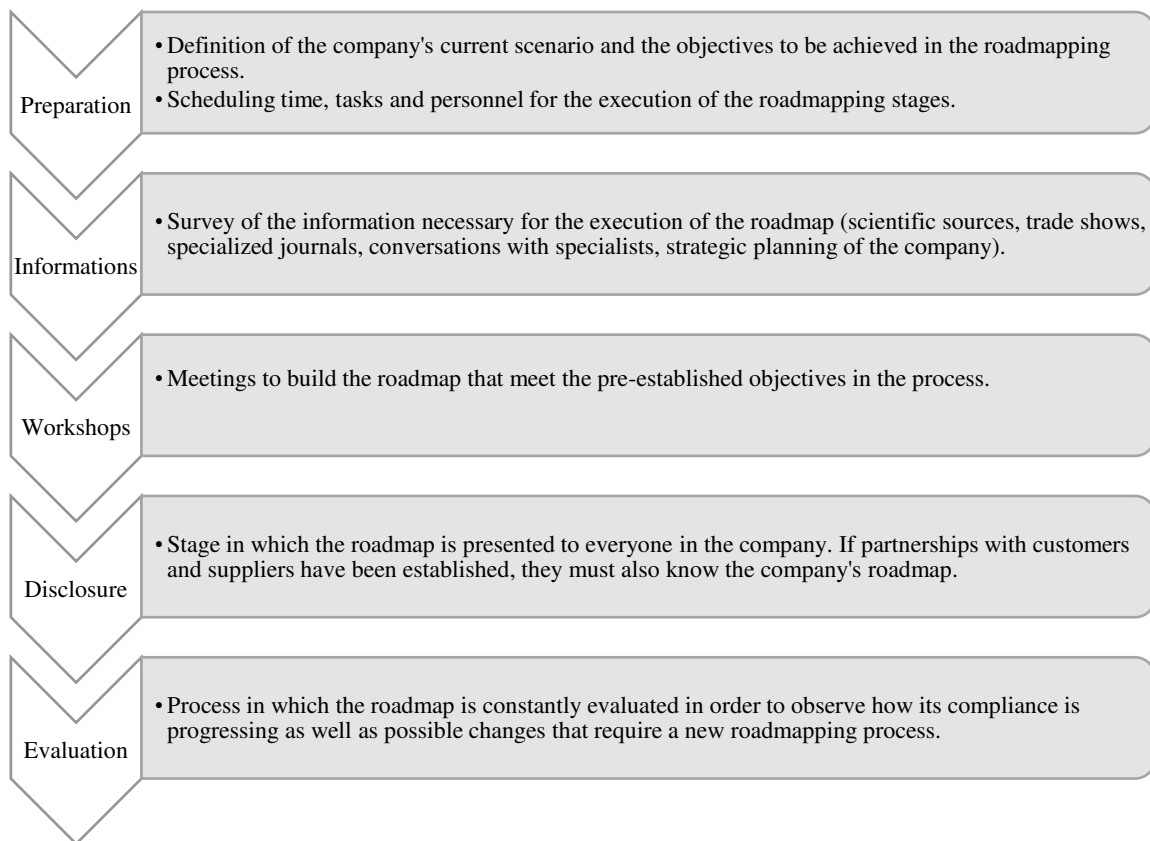


Figure 5. Roadmapping for building the innovation roadmap

Preparation and information corresponding to the first stage of the process must be carried out by the company's managers as well as those responsible for roadmapping, who will select the staff that will participate in the workshops of the stages of generation and selection of ideas and planning and execution.

The workshops must be programmed for the participants to have all the necessary information and enough time to complete the steps. The company must provide the necessary physical space and materials.

Disclosure is the stage in which the roadmap resulting from the work is presented to employees, suppliers, and customers.

For the evaluation, a protocol defined by those responsible for the roadmapping project in the company must be followed. According to the area selected, the members who will participate in the evaluation meeting are requested to identify whether the objectives are being achieved.

### **3. Research Methodology**

This section presents the steps followed to conduct this research, which is classified as applied scientific research. The objective is to generate knowledge to be used in the construction industry. It started with a bibliometric study when the materials gave a basis for the theoretical foundation of the research. For its development, the Design Science Research (DSR) method was used, which enabled the creation and validation of the proposed artifact - civil construction innovation roadmap - through a case study.

#### **3.1. Bibliometrics**

A literature review was carried out based on bibliometrics that is used for research systematization, mapping the origins of existing concepts and highlighting the main theoretical lenses existing in each subject (Araujo, 2006) on the selected theme.

By defining the research object and its problem question "How to use roadmapping to implement and manage innovations in a construction company?", we sought to define the themes that would be necessary for the theoretical basis of this research: innovation in companies, innovation in civil construction, innovation management, strategic planning, and roadmapping.

Web of Science and Science Direct databases were used and the topics in English were researched: innovation in companies, innovation in the construction industry, management of innovation, and roadmapping, such as the connectors *and & or*.

The search for these keywords returned 375,678 articles. Separating the articles from the last five years and in journals with A1 or A2 qualifications, the number came to 13,679 articles. Selecting the search to present the terms searched in the title, we arrived at 1,350 articles, and, from these articles, 300 articles with the largest number of citations were selected and 95 articles were used by reading their abstract.

#### **3.2. Design Science Research**

The Design Science Research (DSR) method is science-oriented toward the generation of knowledge, aiming to design and develop solutions to improve existing systems or create artifacts that improve human performance in society or companies seeking satisfactory results (Dresh, Lacerda & Antunes, 2015). This method suits the main objective of this research to develop a roadmap for the implementation and management of innovations.

The methods presented were used as shown in Figure 6. After doing an exhaustive bibliography analysis and a case developed, it was possible to understand the problem and define the parameters of the artifact proposed as a roadmap for the implementation and management of innovation in the civil construction industry in Brazil.



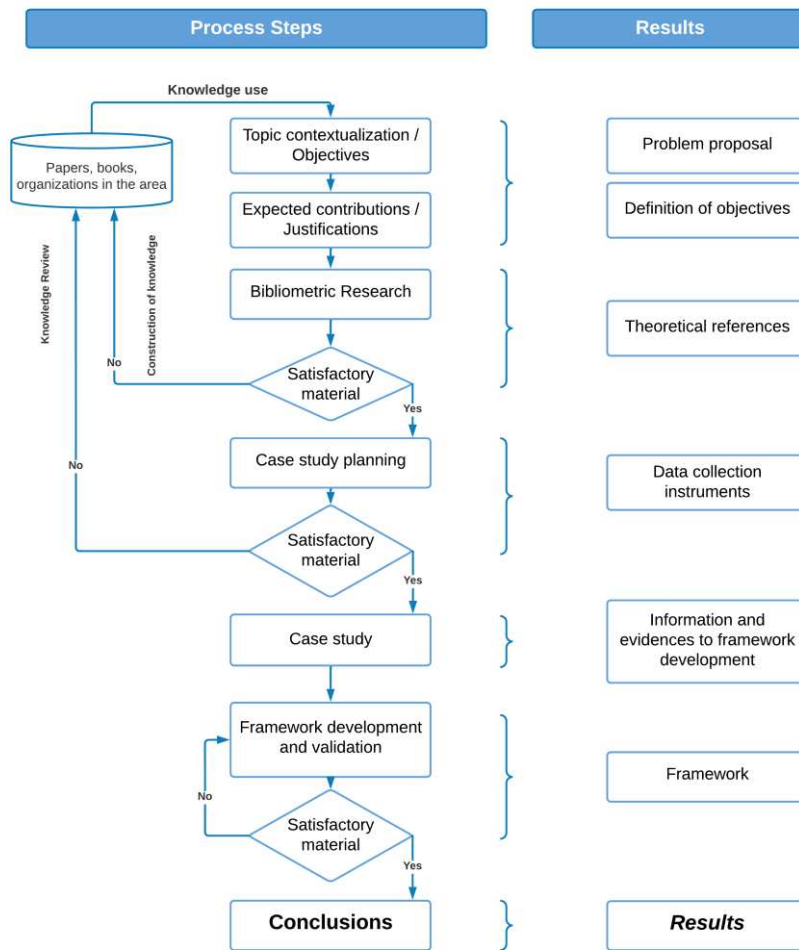


Figure 6: Research design

For the validation of the developed artifact - the civil construction innovation roadmap – the present study was focused on a case study, intentionally selected, as the conditions and complexity of the study analysis demanded specific data from a particular company to investigate a certain contemporary phenomenon within a real context (Cauchik, 2007). The sources of evidence used in the study were company documents, observation of participants, annotation of the successes and errors of the model, as well as interviews with those involved in the process.

The study was carried out at the company Vip Serviços e Construções, following the steps proposed by Cauchick (2007): defining a theoretical conceptual framework, planning the case, conducting the study, collecting data, analyzing data, and generating reports.

#### 4. Results of the research

The case study is a qualitative method that contributes to a better understanding of events that occur locally and individually, as organizational processes (Yin, 2001). As previously mentioned, the company chosen for the case study was Vip Serviços e Construções LTDA. The enterprise has operated in the civil construction sector since 1995 with the following vision: become a reference in the execution of high-standard works and fine carpentry in the greater São Paulo as well as in the Vale do Paraíba region, representing around 10% of the market share in its city of origin (Company Files, 2021).

Five propositions were defined, based on the roadmapping in the company and the theoretical framework that supports the development of the study propositions: a) the roadmap increases communication between managers, employees, and suppliers, which is an important characteristic in the implementation and management of innovation; b) the roadmap demonstrates in a clear and organized way the company's objectives and the paths to reach them in the foreseen time; c) the roadmap helps in the process of researching, defining, and implementing

innovation in the company; d) the roadmap integrates the organization around its innovation objective; and e) the roadmap allows the management of innovation in the company's product, process, organizational, and marketing areas.

#### **4.1. Data Collection**

Data collection involved observations, document analysis, and interviews carried out at different stages of the case study: a) preparation roadmap; b) development of the innovation roadmap; and c) validation of the innovation roadmap.

#### **4.2. Preparation roadmap**

The case study was carried out following the proposal defined in this work, starting with the preparation roadmap, and seeking market and company data to support the definition of the objectives to be achieved by the roadmapping process.

Market data was obtained mainly from CBIC, which provides real estate indicators quarterly on current and future scenarios, focusing on marketing digital innovation, to insert the objective of the brand in the new media and social networks. Documents referring to social media trends were also selected. The company's data were obtained through observation and document analysis.

During the roadmapping process, the company kept two works in progress: a renovation of a commercial property of approximately 120m<sup>2</sup> consisting of an adaptation of commercial property for a future store and a work of approximately 100m<sup>2</sup> of the deck added to a round pergola of 4 m in diameter above the hot tub.

During the observation period, the presence of company professionals and contractors in addition to the responsible architect can be seen. The foreman is responsible for the organization, for the process of reading the project, as well as for the integration between all workers, coordinating the logistical process to ensure that one worker does not disturb or delay the work of the other. The foreman is also responsible for managing the stock of inputs and communicating in advance about the need for materials for the works.

When asked about innovation, company's workers were familiar with the topic related to technologies, such as cell phones and computers, and new types of televisions. However, when asked about innovation in the civil construction environment, few were able to give an opinion on the subject.

The architect showed knowledge on the subject, however, when asked about the innovations adopted in his projects, he informed that his focus was the traditional construction in which professionals are already used to working and clients are already familiar with requesting. In this traditional mode, the architect highlighted that more zeal innovations of the tools allowed to speed up the work, in addition to gains in preventing the exhaustion of employees.

Workers involved with internet and monitoring systems cited disruptive and incremental innovations that could occur in their areas and that would improve and increase the efficiency of their services, such as optical fiber, wireless monitoring, digital data center, data mining, and protection systems of the environment in case of invasions.

In the construction of the deck and pergola, workers reported that they already had training regarding innovation, since the round pergola is an innovation that was developed by the company. They discussed the new execution technique that was improved and developed.

#### **4.3 The roadmapping process**

For the development of the innovation roadmap for Vip Serviços e Construções LTDA company, the steps defined in the developed artifact were followed: a) planning; b) selection of personnel to participate in the roadmapping; c) workshop; d) construction of the innovation roadmap; and e) dissemination of the innovation roadmap.

##### **a) Planning**

The planning process was carried out together with the company's owners, seeking to define the objectives and goals to be achieved with the roadmap. The need to survey indicators and innovation possibilities in all areas helped the company in the process of researching, defining, and implementing innovation. However, data selection occurred only assertively after defining the objectives and possibilities that the company presents.

b) Selection of personnel to participate in the roadmapping process

After surveying the documents that would serve as the basis for the discussions in the roadmap preparation, obtained from entities and qualified professionals in each area of innovation, it was decided that it would be better for the company to have the participation of the partners, of three masters, who are linked to the company, a supplier of raw materials who owns a lumber company in the region that has worked in partnership with the company for over ten years, a client, and an architect who designs and monitors the projects to be carried out by the company.

c) Workshop

Between 2020 and 2021, during the execution of the workshop, the country was experiencing the COVID-19 pandemic; therefore, participants with any symptoms were asked not to participate in face-to-face activities. However, all participants selected were well and their body temperatures were checked. Masks and face shields were worn throughout the process.

A face-to-face lecture was scheduled for the beginning of the activities; however, a Youtube lecture was presented, and the interaction and exchanges, and possibilities of questions were left for the next experience.

The participants showed dedication to the process, studying the documents available and researching others to be discussed.

During the workshop stages, there was constant interaction between all the participants. The exchange of experiences between the designer, the raw material seller, and the company's personnel, always discussed the best possibilities, and the proposed ideas were summarized in a consensus to be consolidated in the innovation roadmap.

d) Innovation roadmap construction

After the workshop, the company's partners consolidated the ideas and information proposed in the workshop thus creating the company's innovation roadmap. In this process, the volume of information and its quality were observed, as well as the information that emerged through the proposed activity in the four areas of innovation - product, process, organization, and marketing.

Figure 7 shows the result of the roadmap obtained. The roadmap was presented to employees and then it was posted on the works in progress. The roadmap was presented and distributed digitally to the company's suppliers and customers thus enabling the alignment of objectives and demand forecasts for both.

	Pre workshop	Workshop		Post workshop
	Evaluation of scenarios and definition of objectives - gate	Selection of ideas - gate	Planning and execution - gate	Evaluation and feedback
Product	Research in journals in the field, institutions, such as CBIC, papers, and through survey research with customers and suppliers, defining the objective to offer faster and cheaper works.	During the workshop and following the company's objectives, the feasibility of the options was studied. It was decided to work with EPS Construction and Construction with concrete and PVC.	In the workshop, employees were selected to be trained and the definition of the execution of a 100m <sup>2</sup> work with two technologies for learning and evaluation.	Quantitative evaluation measures and compares the time of the work and their costs by the company's managers and by qualitative research with customers and partners.

<b>Process</b>	Evaluation of new technologies available in institutions, such as CBIC and websites of specialized companies.	With the completion of the workshop, the tools of the Argafast line were chosen from the options presented.	The collaborators were selected for training in the courses and the guidelines for the submission of the new process produced for the patent were defined. Enter the process at the INPI.	Qualitative evaluation of managers observing execution times and employees regarding performance, easiness of use and ergonomics.
<b>Organizational</b>	Conducting research on scientific articles, seeking the best management practices in the field	With the workshop, the BIM and Construct App were chosen.	Planning for the decentralization of decisions, increasing the autonomy of employees, defining those responsible for training in BIM and the selected App, purchasing the program and the App, and contracting the courses.	Evaluation of managers with a focus on easiness and agility in planning and employees' evaluation on simplicity and precision in methods.
<b>Marketing</b>	Conducting research regarding competitors' marketing strategies compared to the company's marketing strategies.	During the workshop, among the proposed options, the use of Instagram for the company's new communication strategy was defined.	During the workshop, Instagram management planning was carried out, definition of training in the field, and partnership with micro influencers in the region.	Assessment of managers observing revenue and engagement on social networks.
	January 2021	February 2021	July 2021	July 2022

Figure 7. VIP Roadmap – Services and Construction

e) Publication of Innovation Roadmap

With the consolidation of the roadmap, a meeting was convened with all the company's workers to present the result of the roadmap and the company's new actions to achieve its goals.

There was greater confidence on the part of employees as they were involved in the process, as well as a greater acceptance of the new guidelines, which represents a welcome and expected change on the part of managers.

With the roadmap completed, including its dissemination, four people were chosen for the interviews to validate the tool developed and presented in this work. The interviews occurred in a semi-structured way and according to the participants' schedules and availability. One interview was conducted in person, two by WhatsApp, and one by telephone. The conversations were transcribed and sent to the interviewees to validate their answers and agree to publish, only omitting their names.

From the workshop participants, the company's partner, the architect, a master builder, and the supplier were chosen for the interviews. The themes were discussed to validate and improve the tool according to the propositions raised and to answer the research question. Comments that could contribute to the themes were selected, as can be seen below.

a) Master of works

- Theme 1: communication.

For those of us who have worked on this for many years, we know that communication in our area of activity faces animosities of each work sector. The tile settler is uncomfortable with the bricklayer, who bothers the painter, who believes that the architect only knows how to use paper. Having a tool like this and the experience of everyone being able to work together toward a goal, I believe greatly improves communication between all of us.

- Theme 2: organization, and clarity of information.

Normally, many voices are heard throughout the construction process. Demands of several people, which end up confusing and delaying the production process, so being able to have a figure like this affixed to our construction sites makes everything organized. And it is clear to all participants of the work that can understand the objective to be achieved and the owners' expectations regarding their performance.

- Theme 3: assistance in choosing, implementing, and managing innovation.

When new technologies arrive to construction sites, they usually face some resistance as they are practically imposed on workers, I believe that with our participation in the company's choices and decisions, this process will be facilitated.

- Theme 4: team integration.

I enjoyed the experience. In no other company I've ever worked for I have been able to participate in an activity like this, as there were people from all areas. I believe we have promoted better integration between everyone, but we'll wait for the next executions to confirm.

- Theme 5: efficiency in all areas of innovation.

From what was proposed to us before starting the process, I believe that we have discussed the objectives, goals, and paths to be followed to achieve them in all the proposed areas, which creates a great challenge for the company, but we are committed to catching up.

## b) Supplier

- Theme 1: communication.

With the door open, we have contact and communication with all the participants of the executions. Architects come to observe the new materials, customers make budgets and purchase their wood and carpenters pass on their lists and needs so that we can serve them. But gathering all parts involved in a room and with a focus was an aggrandizement experience, without a doubt.

- Theme 2: organization and clarity of information.

The process was very well organized. The materials that were sent to us along with the last briefing, made everything very clear and the workshop was also very organized with the schedules always placed and the focus to be observed at each moment. I found everything very clear and transparent.

- Theme 3: assistance in choosing, implementing, and managing innovation.

Understanding the needs that the company has, and its trends will also help us to jointly supply the materials arising from this new demand. And we have time to adapt to this, which I believe is the great key in this implementation process, where everyone must work together and, on our part, supply the needs of differentiated materials.

- Theme 4: team integration.

As I said, we have the facility to be daily exchanging information with all the gears of this mechanism. But this is the first time that, together, each one in their area, we managed to discuss matters in a unified way.

- Theme 5: efficiency in all areas of innovation.

Of all the topics covered in this experience, the one that I will bring most to my company is organizational innovation, where I share the decisions and goals taken by VIP. And I intend to adopt software that facilitates and improves our administration.

## c) Architect

- Theme 1: communication.

We have some communication difficulties in our sector, where the information ends up being passed on through too many ears until it reaches those who will carry out the work. With a complete tool like this, I

believe that even our office can benefit, investing in innovation workshops also to our company, which has its peculiarities and differences about VIP even being in the same sector.

- Theme 2: organization, and clarity of information.

I believe that the best part of organizing the experience was the materials sent in advance, which allowed us to study and understand the demand that would be charged, in addition to guiding our search for materials that we believed could also be useful to the process.

- Theme 3: assistance in choosing, implementing, and managing innovation.

From what I saw, it seems that the contribution of each one in the choice of trends and technologies that VIP will work with was very significant and the company had good receptivity throughout the process with all the information and visions that each one shared.

- Theme 4: team integration.

There was clearly a little tension at the beginning among all the participants, some were a little embarrassed. But with time and interactions, it passed, and the dynamic presented itself as very fluid and integrating all and all opinions.

- Theme 5: efficiency in all areas of innovation.

Several paths to be followed in all the proposed areas were pointed out and defined, logically within the experience of each participant who did not present the same resourcefulness in all areas, but who contributed to their vision.

d) Partner of the company

- Theme 1: communication.

As the founder of the company, I have always understood communication as a way of expressing the execution needs. We had, however, with the preparation and development of the activity, I realized that communication in our company can and will become a differentiated capacity, providing us with better results in the course of our work.

- Theme 2: organization, and clarity of information.

As we prepared this activity precisely thinking about making the information clear and organized, both the information that was passed on in advance to the participants and the information that was obtained in the workshop, aiming to use them in our strategies and the clearer and organized they are, the better their use will be.

- Theme 3: assistance in choosing, implementing, and managing innovation.

The opinions of all people who are directly or indirectly part of our daily work allowed us to choose technologies and innovations that, in addition to being attainable by our company, will give us some competitive advantages over our competitors thus fulfilling the objective of the activity and aiming at our forecasts of increased demand for the coming years, in addition to the insertion of the brand in the Vale do Paraíba region.

- Theme 4: team integration.

I had never thought that we could develop an activity like this in which everyone could give their opinion and interact constructively. We have faced difficult times for the business in recent years and it is very gratifying to see everything recovering little by little with more determination, with more knowledge, and with more disposition, which reinforces the certainty that the more knowledge, the more balance, and wisdom to experience all the ups and downs of any company.

- Theme 5: efficiency in all areas of innovation.

Of all the proposed topics, we are very grateful to all the participants who dedicated themselves to the fullest, understanding the briefing, our needs, and capabilities now, understanding the information provided, and bringing even more content to enrich the workshop in all the proposed areas that we will remain firm to fulfill the defined objectives.

## 5. Discussion and interpretation of results

Organizations need to transform their communication processes into communication capabilities (Johannessen & Olsen, 2011), which constitute a system that preserves value creation and combines economic and technical communication, communication management, and social and cultural communication (Johannessen & Olsen, 2011). The roadmapping process is widely used for general planning and strategy management, promoting communication between the most diverse sectors of the organization (Lu, Chen & Yu, 2019).

Regarding the company studied, it was observed that communication was restricted and rigid usually in a top/down system. The demand originated from the customers and was passed from the company's owners to the masters who presented the demands to the bricklayers and helpers for execution.

Considering the preparation proposed by this research in the roadmap for the civil construction enterprise, in the first phase, some information regarding the company's strategic objectives began to be shared with employees of all hierarchical levels, in addition to customers and employees, changing the old information flow allowing greater fluidity.

The responses of the employees and the owners showed that the change in the communication system proposed and experienced during the workshop presents a positive perspective for the near future, considering the greater easiness of implantation of innovation in the company, that is, new products and processes face fewer restrictions on the part of employees on a day-to-day basis.

Therefore, Proposition 1 can be raised: roadmapping increases communication between managers, employees, and suppliers, which is an important characteristic in the implementation and management of innovation.

For Lu, Chen, and Yu (2019), companies use roadmapping to develop medium and long-term strategies for the execution of business objectives, managing technical strategies, integrating technology and operations, developing technology at an enterprise level, governance and practice, and research and development planning. The roadmap presents all the information obtained and consolidated in the roadmapping process in a clear and organized manner.

A large volume of information that is developed along the roadmapping allows this information to be used and become a differential for the company, thus, it needs to be structured in an organized and clear way, which is the objective of the roadmap.

Observations in the works showed that information circulated without documents for its organization and that employees knew little about the company's strategic objectives.

During the workshop, it was noticed that the company's employees who participated in the roadmapping process became better acquainted with the strategic objectives. In addition to participating and contributing to the activity, they started to have in their hands and attached to their work, the roadmap that contained the results of the information that was discussed in a simple and clear way.

The clear and objective roadmap demonstrates the company's intentions and the paths that will be followed over time, preparing everyone for each step that will come. Therefore, the roadmap needs to present information in a clear and organized way to all members of the company, its partners, and customers, which allows creating Proposition 2: the roadmap demonstrates in a clear and organized way the company's objectives and the paths to be reached in the foreseen times.

The roadmap can provide a means to improve an organization's "radar" to extend planning horizons and to identify and evaluate potential threats and opportunities in the business environment (Martin, Ralf, and Phaal, 2013). The collection of information necessary for the execution of the roadmapping process expands the horizons and the company portfolio of innovations (Martin, Ralf, & Phaal, 2013).

The company under study is a traditional company and presented issues related to innovation were little considered. It was noted that roadmapping made the owners dedicate themselves and research the topic. Among the proposed objectives and the organization's capabilities, a portfolio of possible items to be implemented was created, in addition to defining priorities and deadlines for implementation.

Roadmapping generated a change in the company's strategic planning that can be observed with the change in its mission. The mission Vip Serviços e Construções LTDA company carry out commercial and residential works in an innovative way, with quality and fair price, making the process of building their dreams a pleasant experience for our customers thus generating profitability and the affirmation of the brand of Vip Serviços e Construções LTDA.

Therefore, it is possible to raise the following Proposition 3: roadmapping helps in the process of researching, defining, and implementing innovation in the company. The implementation process needs to be observed with more time to conclude, even though the company's expectations are high in this regard.

It may be necessary to bring in experiences from outside the organization in related technology fields, markets, or industries, to gain a broader view of potential opportunities and threats, integrating all participants around its objective (MARTIN, RALF & PHAAL, 2013). This demonstrates the potential of roadmapping to integrate participants even if they do not come from the company under study.

Harmonic integration was observed among all workshop participants even before the workshop occurred. From the moment the information was received, a WhatsApp group was created among everyone to discuss the proposed information and objectives, in addition to collecting more information for roadmapping.

The company expects that the roadmap presented in the works, preceded by its presentation, can aggregate the team toward the objectives, goals, and proposed paths. However, more observation time would be needed to assertively complete the integration of the entire team.

It is concluded that workshop participants showed clear integration, starting even before the workshop, and continuing even after its conclusion, which allows the construction of Proposition 4: roadmapping integrates the organization around its innovation objective.

There are roadmaps aimed at defining the innovation strategy and which have been used to define the trends and needs of each sector of activity, in terms of defining strategic objectives, innovation goals, and common actions to all involved (Gouvêa *et al.*, 2019). This type of roadmap is generated as a function of the market for products and technologies that point to an increase in the company's competitiveness.

There are also roadmaps for planning products and technologies, which are generated to define more specific goals and objectives related to the development of products and technologies and are used to establish technical and performance requirements for the products to be developed (Gouvêa *et al.*, 2019).

It was observed that the company under study showed little contact with innovation and it did not have any system for its management. The result obtained in the roadmap demonstrates that innovations will be implemented in the company, their sequence, the periods of such activities, and the evaluation process for each in all the proposed areas.

The analysis of the propositions raised here showed that the method proposed in this research favors the construction of Proposition 5: roadmapping allows the management of innovation in the areas of product, process, organization, and marketing of the company. More observation time is needed to assess the efficiency of the proposed tool in the construction industry.

## **6. Conclusions**

The development of a specific roadmap for the construction enterprise using Design Science Research and its validation with a single case study showed that this research fulfilled its main objective: develop a roadmap to be used by a small civil construction company for the implantation and management of innovations, raising some theoretical propositions for future studies.

The study also allowed to raise practical propositions to be tested in future studies for the creation step by step of roadmapping. Such propositions are based both on the roadmapping carried out in the company under study and on the theoretical framework used aiming at a link between what is proposed by the literature and the results of the empirical research.

It can be observed that effort and perseverance, in addition to knowledge, and partnerships to be established by the company studied are fundamental in promoting innovation, whether with suppliers, customers, or educational institutions. It is important to highlight the positive achievements that the research brought to the company, expanding the company's focus on innovation and the new organizational and technological guidelines of the market.

The case study allowed the company to incorporate innovation into its guidelines, developing a roadmap that meets its objectives and is within its organizational capacity.

The limitations of the research, according to Cauchick (2007), refer to the importance of replicating the experiment in other companies to verify and compare the results, which allows obtaining more robust data and generalization of the results. In any case study, there is a bias on the part of the researcher; however, we aimed to



mitigate this limitation by presenting the transcripts of the interviews to the interviewees to confirm them and making them available for the reader to follow the conclusions.

Time was also a limiting factor, both for interviewing all workshop participants and for testing the artifact in other companies. The process needs to be continually re-evaluated and the suggested propositions deserve detailed investigation.

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