Critical Success Factors and the "Iron Triangle": A study in Project Manufacturing Environments

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Abstract

Complex, high-level customization products are usually produced in an environment known as Project Manufacturing, where each product is executed through a specific project that must meet defined goals of scope, cost, time and quality, which is known as "iron triangle". The performance of these projects can be influenced by elements known as Critical Success Factors (CSFs) that are widely discussed in the scientific literature without, however, having a consensus on their influence on the cited environment. Thus, this study aims to analyze the influence of CSFs on the chance of reaching the goals established for the projects in the "iron triangle". Despite the high number of CSF cited in literature, just a few are statistically significant to explain this phenomenon. They are: team integration, clear objectives, record lessons learned, use previous technologies, insert time and money reserves, and project risks identification.

Keywords: Critical Success Factors, Project Manufacturing, Iron Triangle

1. Introduction

Most of the world's product manufacturing is carried out by systems based on mass production where production lines or manufacturing cells generate a massive amount of a specific type of product. However, complex, high-level customization products cannot be produced in this way, they require a different approach known as Project Manufacturing.

According to Yang (2013), Project Manufacturing, also known as Engineering-to-Order (ETO), is associated with chaotic production in situations of high complexity and uncertainty where each product is the final result of a project. In general, it involves the production of fully customized items, usually in a few or only one unit, with the product design being exclusively developed from the customer specifications. To Carvalho et al. (2015) Project Manufacturing is becoming increasingly important among production systems, particularly for the delivery of customized products. However, according to Gosling & Naim (2009), this type of environment has received less attention from researchers than high-volume production of standardized products like the Make-to-Stock (MTS).

Project Manufacturing often involves the execution of multiple projects at the same time, with each one at a different stage and dividing resources into interactions that involves multiple parallel and sequential activities in an environment of great uncertainty (Fox, 2008). Typically, projects in this environment involve design, engineering, procurement, manufacturing, assembling and commissioning activities, resulting in products such as heavy machinery, ships, oil rigs, and others. However, each project presents a unique context with specific objectives, actors and constraints (Mello et al., 2015).

It is a highly challenging environment, due to the complexity of the products, the sporadic demand for different items that require different production methods, and the overlapping between engineering and production activities (McGovern et al., 1999). In addition, the projects developed in this environment are subject to various risks and narrow limits of time, resources and quality levels. Thus, the search for a good performance in these environments demands knowledge about any elements that can influence it.

Regarding this context, in the scientific literature on project management there is a line of studies that addresses the so-called "Critical Success Factors" (CSF), a term that was initially used by Rockart (1982) to designate "vital elements" to the success of any kind of project.

In fact, Inayat et al. (2015), suggests there is currently consensus among researchers that much of the success achieved by any project is related to the presence or absence of CSF, which should be carefully observed by managers because of their impact on project performance. However, despite their recognized relevance, there are few studies dedicated to providing sets of CSF for specific projects and even fewer studies that sought to empirically identify the relationship between these factors and the performance of the projects. (Ika et al., 2012).

In any project, one of the most important aspects in terms of performance is the achievement of its goals, specially scope, schedule, budget and quality levels, which is known as the "iron triangle".

Specifically on project manufacturing environments, the scientific literature of the area shows the existence of a gap on this subject, and there are no works that demonstrate which are the CSF that can influence the performance of the projects in this environment. Considering this scenario, this work has as main purpose to analyze the impact of CSFs on Project Manufacturing performance in the "iron triangle". More specifically, the objectives of the paper are:
1. To identify in the scientific literature the CSF with adherence to environments of Project Manufacturing;
2. To verify which are statistically significant CSFs to explain performance in the iron triangle;
3. To analyze how the chances of reaching the established goals for the iron triangle are influenced by CSFs.

To achieve this objectives this article is structured as follows: after the introduction a review of the literature on CSF is presented, the research methods used, the presentation and analysis of the results and finally the conclusions and final considerations of the work

2. Critical Success Factors

There are many types of CSF’s cited in scientific literature and in this section they were categorized in order to a better comprehension and supporting of the study. The first category is showed in table 1 and were entitled “Factors related to human resources”.

Table 1. Factors related to human resources

CSF	**References**
Empowerment	Iyer & Jha (2005), Jin & Ling (2006) e Rezaiea *et al.*(2009).
Project manager leadership	Damodara (2000), Pheng & Chuan (2006) e Yang *et al.* (2011)
Project team integration	Ferriani *et al.* (2009), Zhang & He (2015)
Project team flexibility	Mccomb, Green & Compton (2007), Zhang & Zhou (2013)
Conflict treatment	Cheung & Chuah, (1999) e Laslo & Goldberg (2008)
Project manager experience	González *et al.* (2011)
Team experience	Fricke & Shenrar (2000), Tishler *et al.* (1996) e Lee *et al.* (2013)

The first CSF presented in Table 1 is the empowerment, which means broadening the decision-making power of project team members, which makes work more agile and staff more motivated, increasing the likelihood of success in the project (Rezaiea et al. Al., 2009). According to Yang et al. (2011), the motivation of the team may also occur due to the leadership of the project manager. Motivated teams tend to be more productive, with a positive effect on performance and consequently on the level of success achieved.

In addition to the question of leadership, the literature points to the experience of the project manager as another relevant CSF. In this regard, González et al. (2011) emphasize that to lead a project to success a project manager must have the experience in the field of the project.

Regarding to the project team, three characteristics can be highlighted as CSFs. The first is its level of flexibility, that could be defined as the ability to respond to change effectively and efficiently, which is critical to the success of the Project (Zhang & Zhou, 2013). The second is their level of experience, which according to Lee et al. (2013) is extremely relevant for the performance of complex and integrated projects. The last feature is their integration capability, which involves sharing their tacit knowledge during problem solving and improving project performance (Zhang & He, 2015).

The last critical success factor in this category is the conflict management, which involves resolving disputes that can occur among stakeholders during the project life cycle. Conflicts reduce staff motivation and delay work activities. In this respect, Wei et al. (2015) point out that inadequate conflict management in a project can lead to failure.

The second category is entitled “organizational factors” and is presented in Table 2.

Table 2. Organizational factors

CSF	**References**
Project management authority	Might & Fischer (1985) e Belout *et al*. (2004)
Organizational structure	Laslo & Goldberg (2008), Creasy & Anantatmamula (2013)
Change management	Forsman (2008) e Wang *et al*.(2008)
Top management support	Cooke-Davies (2000), Rezaiea et al.(2009), Ahmed *et al*. (2016)
Project Management Office	Young & Samson (2008) e Ko *et al.* (2015)

The first item in table 2 is the authority delegated to the project manager, which can make it "independent" of the organization structure, offering the ability to obtain organizational resources for the project autonomously which acelerates decision making and problem solving. In this respect, Belout et al. (2004) argues that the level of authority attributed to the manager is an element significantly associated with the success achieved by the project.

Another important element for the project performance is its organizational structure, which has influence in several aspects such as the ease of allocating resources and the agility in the decision making, being able to vary from a classic functional structure, directed to continuous activities until a totally projectisized structure, with the capacity to adapt to the needs of the project. For Creasy & Anantatmamula (2013), the organizational structure is one of the most important CSFs, since successful projects are supported by structures focused on this purpose.

With regard to change management, when done correctly, it can allow the organization to better handle risks and have the flexibility to take care of situations where the scope is unstable, which allow a more harmonious relationship with the clients of the project, improving the chances of success (Wang et al., 2008).

Top management support is a critical element for the outcome of projects (and one of the most cited CSFs in the literature). With this support, which is individualized in the form of a CEO, Chairman, President or Director of the company, it is possible to obtain resources and avoid conflicts more easily and having a key contribution of the project (Ahmed et al., 2016).

The last factor in this category is the presence of Project Management Office (PMO), which consists of an organizational unit dedicated to providing support to the projects carried out in the company through document organization, resource allocation, training, storage and availability of knowledge Lessons learned from previous projects, and project management and control. According to Ko et al. (2015) PMO activities tend to increase organizational competence in project management and consequently better performance.

The third category is entitled “Factors related to stakeholders” and is presented in Table 3.

Table 3. Factors related to stakeholders relationship

CSF	**References**
Effective communication	Fortune & White (2006), El-Saboni *et al.* (2009) e Cervone
Incentive mechanism	Bower (2002) e Meng & Gallagher (2012)
Desincentive mechanism	Bubshait (2003) e Meng & Gallagher (2012)
Suppliers integration	Schoenherr & Swink (2012) e Horn *et al.* (2014)
Suppliers selection	Luzon & El-Sayegh (2016)
Clients involvement	Ribeiro (2013)

The first factor to be highlighted in Table 3 is the effective communication. According to Cervone (2014), maintaining effective communication has several impacts on the project, such as the increase of interaction with stakeholders which keeps them engaged, avoids mistakes at work and generates better results increasing the chances of success.

Another relevant aspect to the success of a project is the inclusion of incentive and disincentive mechanisms (bonuses and fines) in contracts, which according to Bubshait (2003) aim to reward or penalize suppliers based on their performance. The use of these mechanisms can reduce time, costs and improve the quality of delivered items (Meng & Gallagher, 2012).

Regarding to the relationship with suppliers, Schoenherr & Swink (2012), emphasize that the integration with these stakeholders promotes positive results in terms of flexibility and reliability of deliveries. On this subject, Horn et al. (2014) emphasize that companies with high levels of integration with suppliers are particularly successful in their projects.

Thus, because suppliers plays a very important role in the project, another critical factor that deserves to be highlighted is its selection process, that will have a direct influence on the level of success achieved. This process must be done in a careful manner, taking into account aspects such as quality, price, delivery, service level, guarantee, technical capacity, productive capacity, historical performance and even geographic location (Luzon & El-Sayeh, 2016).

In addition to supplier relationships, the success of a project is also highly dependent on the level of involvement with the clients (last FCS in Table 3). The higher the level of clients participation in a project, the easier it is to identify their requirements, establish quality criteria and reduce changes solicitations. Thus, the active participation of the client in the project must be stimulated from the beginning of its life cycle (Ribeiro et al., 2013).

The fourth category is entitled "Factors related to project management" and is presented in Table 4.

Table 4. Factors related to project management

CSF	**References**
Clear objectives	Ahmad & Cuenca (2016)
Clear documentation	Van Der Velde & Van Donk (2002)
Project planning	Iyer & Jha (2005), O'Connor *et al.* (2016).
Requirements planning	Karim Jallowa *et al.* (2014)
Multitasking prevention	Yeo & Ning (2002)
Critical resources analysis	Zhan & Jin (2014)
Projects interdependencies	Gustavsson *et al.* (2016)
Limitating factors analysis	Ash (2009)
Lessons learned	Chronéer & Backlund (2015)
Risk identification	Hwang & Lim (2013)
Risk analysis	Yet *et al.* (2016)
Risk response	Zhang & Fan (2013)
Time and money buffers	Hans et al.(2007), Zhang *et al.* (2015)
Risk control	Wang *et al.* (2010)
Baseline control	Lechler *et al.* (2012) e Zhang *et al.* (2015)

The first element to be highlighted in this category is to set goals clearly. According to Ahmad & Cuenca (2012) this is a fundamental practice to guide the team, avoiding unnecessary work activities and sources of conflict.

Another important aspect is the construction of a clear project documentation. According to Van Der Velde & Van Donk (2002), a good structuring of the key project documents formalizes important aspects at crucial times of the schedule. In general, these documents involve technical aspects such as specifications and scales, and should be available for the stakeholders to be checked to avoid execution errors. In addition, project documentation increases in size along its lifecycle and is consulted by several stakeholders, therefore, it must be made in a well-structured and unambiguous way.

The project planning process, which consists of structuring and preparing for the work activities that will be carried out, is also fundamental for performance. According to O'Connor et al. (2016), planning has a direct influence on the performance of the project in terms of costs, quality and safety, so it must be carried out carefully, taking into account the environment and the particularities of the project.

For Karim Jallow et al. (2014), requirements management allows a more accurate time and cost estimate and avoids unnecessary costs with rework and change. Thus, is a crucial process to ensure customer satisfaction and perceived value in the project.

Another common element in this type of environment is the occurrence of multitasking. This is because resources are used in multiple projects running concurrently, leading to delays in activities and reducing efficiency in the execution of work, so it is fundamental to organize resources in a way that will prevent this phenomenon (Tromp & Homan, 2015).

Zhan & Jin (2014) emphasizes that it is important to analyze the features of the resources used in the projects because some of them are critical to their performance. Such resources may be of a technological nature such as state-of-the-art equipment or high-level professionals. Thus, if project execution is conditioned to these elements, it is fundamental to check their availability and optimize their use among projects.

Projects conducted in this environment are not independent of each other. Project uncertainties, complexity, and risks are amplified due to existing relationships with respect to resources, technical similarities, goals and others, which should be considered during project decisions to increase their success rate (Gustavssom et al., 2016).

Due to its interdependencies, projects often compete for resources (financial, human or technological), which become scarce as they are requested more often. Some of these resources are divided among the existing projects, becoming limiting factors to their development, which leads to delays and increase in costs, being fundamental their identification and adequate allocation for a better performance (Ash, 2009).

Chronéer & Backlund (2015) point out another frequently cited element in the literature on the subject: the recording of lessons learned. This FCS involves the generation of knowledge by the project and its subsequent absorption by the organization for later use. According to the authors, the knowledge can be used within the project itself in which it was generated and also between projects, preventing known problems from occurring and accelerating their resolution.

In project management literature, many CSFS can be found related to risk management. The first one to be highlighted is its identification process, which consists in mapping potential threats or opportunities to the project with the aim of subsidizing Strategies. According to Hwang & Lim (2013), risk identification is important because it significantly reduces uncertainty, making the project team more aware of the events that may occur, allowing them to create better specifications, have more knowledge to analyze technical proposals, improve project communications and establish best contractual practices.

Another element linked to risk management mentioned in the literature is the creation of risk responses. Zhang & Fan (2013) state that it is the identification, evaluation, selection and implementation of actions that aim to reduce the probability of occurrence of risks or reduce their negative impacts. According to the authors, project managers should focus their efforts on this activity to improve the final project performance and their likelihood of success.

Wang et al. (2010) suggests that risk control is paramount for project performance, stating that it is the phase where the previously identified risks are monitored and additional risks are identified, being an especially useful activity to monitor project performance during its execution.

Still with regard to project risks, depending on their severity, Lechler et al. (2012) suggests that it is possible to include time and money reserves to mitigate their effects and to protect work activities that could be completed within the planned baselines.

Fifth category is entitled "Factors related to technical aspects" and is presented in Table 5.

Table 5. Factors related to technical aspects

CSF	References
Communication infrastrutcture	White *et al.* (2016)
Project information system	Pandit & Zhu (2007)
Technical performance control	Pinto & Slevin, (1987)
Commissioning	O'Connor *et al.* (2016)
Previous technology	Li *et al.*(2011)

In Table 5 the first CSF presented is the communications infrastructure, which refers to the elements that support the communications in a project. According to White et al. (2005), especially in complex projects, there must be a system that maintains the integrity and consistency of the data, transmitting and storing them in a way that facilitates the processing of change requests, control mechanisms, lessons learned, and configuration management.

Another FCS present in this category is the technical performance control, which involves evaluation and correction of nonconformities in relation to the work being done in the project and the level of performance of the resulting product, which usually must meet the specifications established by Standards and customers. Thus, the level of success of the project will depend not only on evaluation, but also on costs, schedule and other managerial criteria, but also on an acceptable level of technical performance (Pinto and Slevin, 1987).

In large custom equipment projects (typical of Project manufacturing environments), it is common to have a stage known as commissioning, where the product is installed at the customer's plant and its operation is monitored until it reaches the expected performance. This step is critical to the success of the project, and should be conducted with appropriate engineering support and with direct client involvement (O'Connor et al., 2016).

The last FCS of this category is the use of technologies generated in previous projects, that is, it is applied knowledge that comes from well and unsuccessful experiences that have generated organizational learning. The use of this knowledge (drawings, assembly instructions, manufacturing processes and decision-making experiences) accelerates the project schedule and prevents mistakes to occur again, reducing costs and increasing project success rates (Li et al., 2011).

3. Research Methods

As a way to approach the research with its object of study it is fundamental to carry out the classification of the research, in this way, the present work can be considered as descriptive-explanatory with quantitative approach, and was operationalized by the survey method.

In order to structure the research, a conceptual model was constructed based on the literature review presented in the previous section and based on the assumption that the factors mentioned in the literature can explain the performance of Project manufacturing environments in the "iron triangle".

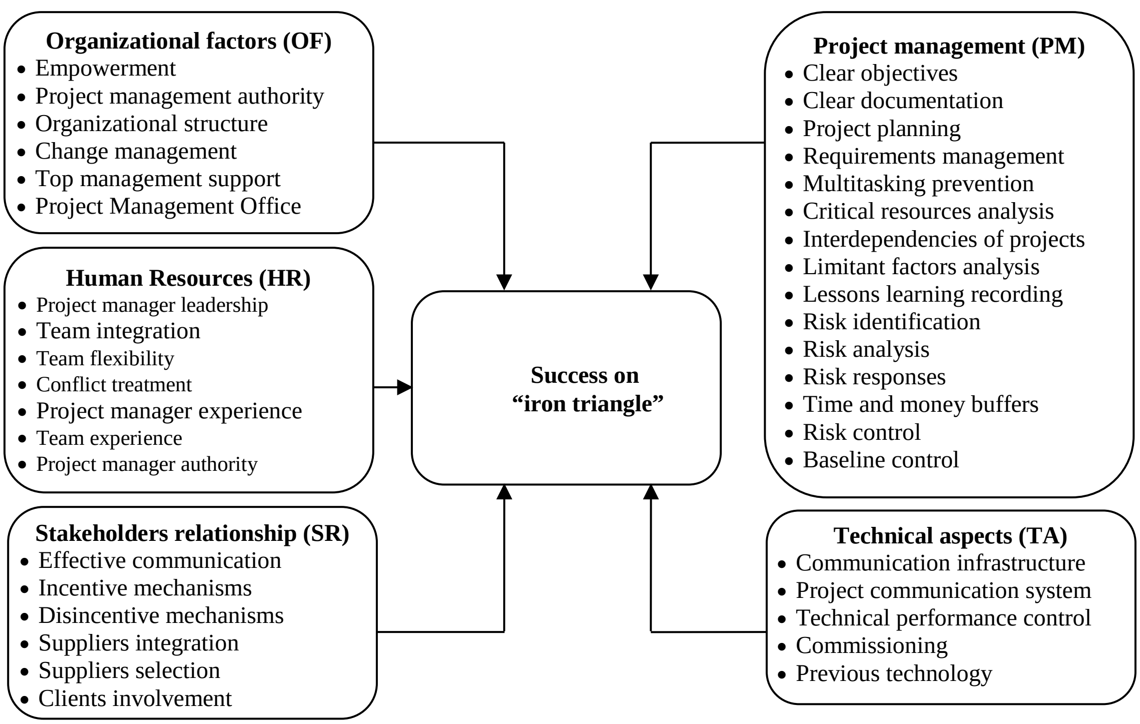

Figure 1. Research model

3.1 Data collection

It was used a judgmental sampling in order to select companies operating in a project manufacturing environment and respondents with adherence and experience with the studied phenomena.

Data collection started with the accomplishment of a pilot test, in the form "test-retest" that involved the application in-loco of a questionnaire structured with likert scale (Ranging from "totally disagree" to "strongly agree") in 30 companies that operate in environments of Project manufacturing. In the questionnaire where presented statements about the presence of the 38 factors identified in the literature. The experience of these professionals allowed, from the feedback obtained, to make small changes in the research questionnaire. The improved research instrument was subsequently sent (this time electronically) to the same respondents and, after the return, the internal reliability indicator, known as Cronbach's alpha, was calculated using the Statistical Package for Social Sciences (SPSS), Obtaining a value of 0.874, sufficient to guarantee its consistency.

After the pilot test, the research continued through two actions: the first consisted of new applications in-loco, with visits to companies and the second consisted of the electronic sending, after profile analysis, and previous contact with candidates identified in discussion groups on project management in Linkedin social network (www.linkedin.com), resulting in 182 valid questionnaires.

3.2 Data analysis technique

The technique employed in data analysis was logistic regression, which aims to discriminate two groups of observations within a sample, differing from linear regression by using a dichotomous or binary dependent variable, which in this study is related to the achievement of not of iron triangle goals.

According to Hosmer & Lemeshow (1989), the logistic regression technique has become a standard method for regression analysis for binary variables, largely used in situations where data analysis involves predicting the value of a categorical outcome variable. To Johnson & Wichern (1998), the logistic regression model is based on the logistic function:

$$f(z) = \frac{1}{1+e^{-(z)}} \qquad (1)$$

$$z = ln\left(\frac{p}{1-p}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_3 X_3 \qquad (2)$$

Where:
p = Probability of response to the ith factor (or covariant)
α = Constant
β_i = Coefficients of the independent variables
X_i = Independent variables

It is important to highlight that logistic regression requires some conditions to be used, as the dependent variable be dichotomous, to include all the relevant variables in the model, to exclude all the irrelevant variables of the model, to guarantee the absence of multicollinearity and the adequate adjustment of the model.

For the use of the technique, the conceptual model of figure 1 generated a submodel, where variables (or CSFs) that did not contribute to the explanatory power were removed. This procedure was performed in IBM SPSS software with the Backwards LR routine.

3.3 Multicollinearity and adjustment analysis

For the evaluation of multicollinearity, Garson (2008) suggests the use of Variance Inflation Factor (VIF), which evaluates the increase of variance due to the presence of multicollinearity, and the VIF limit value to establish if a variable is not collinear is 4 In the present study, the value obtained for FIV was 2,979 indicating that there is no presence of multicollinearity.

On the other hand, the adjustment analysis is conducted to evaluate the validity of the model and was performed by the Hosmer-Lemeshow (HL) test, which evaluates the null hypothesis that there are no significant differences between the predicted and observed classifications. Whent this hypothesis can be accepted, at 5% of significance, the model is capable of producing reliable estimates and classifications. According to Hosmer & Lemeshow (1989), for an adequate fit the model must have at least a value greater than 0.5 in the HL test, and in this work the result obtained exceeded this value (section 5), which reveals that the models have good adjustment for the use of logistic regression.

4. Results and Discussion

The results found by the research are presented in Table 6 where statistically significant CSFs are presented at 1% (***), 5% (**) and 10% (*) significance levels.

Table 6. Results of logistic regression

CSF	B	S.E.	Wald	Sig.	Odds Ratio
Team integration (HR)	1.064	.519	4.199	0.04**	2.898
Clear objectives (PM)	1.195	.520	5.278	0.022**	3.302
Lessons learned (PM)	.610	.326	3.506	0.061*	1.840
Previous technology (AT)	1.932	.699	7.637	0.006***	6.905
Time and money buffers (PM)	.697	.396	3.102	0.078*	2.008
Risk identification (PM)	1.051	.622	2.853	0.091*	2.861
Nagelkerke R^2: 0.512		Hosmer and Lemeshow test: 0.671			

The first relevant aspect to be discussed here is the result obtained by the Hosmer and Lemeshow test, which was 0,671 indicating that the model has adequate adjustment for use of the logistic regression technique. Another important point is the explanatory power represented by the Nagelkerke pseudo R^2, indicating to be able to explain 51.2% of the phenomenon studied.

Among the items presented in table 6 are the Odds Ratio (calculated as the Exp (B)) that represent the variation chances in reaching the goals in the "iron triangle" of the project when it has a CSF when compared to projects that do not have.

The Odds Ratio shows that projects with integrated team have a probability of 2.898 times greater in achieving the goals of scope, time, costs and quality than those that do not have. This result may indicate that the team's ability to share tacit knowledge increases project agility, especially in solving problems, tending to bring it closer to planned goals.

The results also show that projects where goals are clearly established are 2.302 times more likely to succeed in the iron triangle than those who do not. Thus, it is possible that by understanding more clearly what the project seeks, the team can focus efforts on activities that add value and bring the project closer to its target.

Another statistically significant CSF is the recording of lessons learned. In table 6 it is possible to see that projects where the obtained knowledge is stored in explicit form has a chance of success in the "iron triangle" 1,840 larger than projects in which this record is not realized. In this sense, the lessons learned during design serve as a repository that is consulted by the team when necessary, avoiding new problems and consequently improving their performance.

According to the results of table 6, the use of previous technologies also increases the chances of success. In this case, projects that make use of this practice have a probability of success 6.905 times greater than projects that do not, which is the biggest effect caused by a CSF analyzed in this study. This result can be explained by the fact that when it is possible to use technologies developed previously rather than starting from zero point there is a natural saving of time and resources that has a strong impact on project performance.

Regarding the insertion of time and money buffers, the results show that this CSF increases the chances of reaching the goals in the iron triangle by 2.008 times in relation to projects where it is not present. This is a fairly common practice in projects to compensate for uncertainties during planning, allowing any cost variations or schedules to be supported by the buffers and consequently keeping the project within its baselines.

The last CSF to be presented is the identification of risks, whose presence in projects increases the chances of success 1.861 times in relation to projects that do not use this practice. Risk identification enables managers to create measures to protect the project from external events that may have a negative influence on timing, scope, and budget, which tends to improve project performance over efficiency.

5. Conclusions, Limitations and Future Research

This work sought to understand the influence of the so - called Critical Success Factors (CSFs) on performance in the "iron triangle" in Project Manufacturing environments. To achieve this goal, a quantitative research was conducted in the form of a survey in capital goods producers that typically present this type of environment.

The first aspect to be pointed out is that the scientific literature of the area presents a very large number of CSFs in several studies carried out in the last decades, so, to operationalize the work a conceptual model was constructed with those that seem to have more adherence to the projects conducted in Project manufacturing environment analyzed. For analytical purposes, the selected CSFs were grouped into categories: Human Resources, Technical Aspects, Project Management, Organizational Factors and Relationship with Stakeholders.

Although the number of CSFs cited in the scientific literature is large, few presented statistical significance (be it 1%, 5% or 10%) to explain each of the success dimensions analyzed in this study. The model used showed good adjustment indicating that the use of the logistic regression technique is adequate to study the phenomenon being able to explain 51.2% of the data variance. In addition, it was possible to verify that among these elements there is a great variation between the level of influence exerted by each one (with Odds Ratio ranging from 1.840 to 6.905).

It's important to highlight that most of the CSFs that are statistically significant to explain this phenomenon are related to project management practices, indicating that in order to succeed in achieving iron triangle goals, managers should emphasize these elements. However, the greatest influence on the chances of reaching the goals in the iron triangle is in the use of previous technologies (CSF related to technical aspects), that is, to take advantage of the applied knowledge already developed by the organization executing the project.

It is important to empathize that these results have also practical implications. Project managers can use them to support decisions and foment the presence of the CSFs to maximize the chances of project success.

The main limitation of this study is the process of sampling, which is non-probabilistic and does not allow statistical inference (this process was chosen because it was necessary to evaluate the companies that would participate in the research regarding adherence to the topic and the capacity to respond).

These results have also practical implications. Project managers can use them to support decisions and also foment the presence of the CSFs in order to maximize the chances of project success.

For future works it is suggested to expand the analysis to other dimensions of project success, such as organizational learning or customer impact. It is hoped that this work can help advance the project management area, be it in terms of scientific knowledge for the academy or in subsidizing the decisions organizations that have this type of environment.

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