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## **PUBLIC CONSTRUCTION MANAGEMENT: A COMPARATIVE ANALYSIS OF THE VALUE AND DURATION ADDITIVES BETWEEN TWO FEDERAL EDUCATIONAL INSTITUTIONS**

**GESTÃO DA OBRA PÚBLICA: UMA ANÁLISE COMPARATIVA DOS ADITIVOS  
DE VALOR E DE PRAZO ENTRE DUAS INSTITUIÇÕES FEDERAIS DE ENSINO**

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## ABSTRACT

The public constructions promote a great movement of resources. Both the commercial media and academic literature report frequent changes during the execution phase of the construction contracts, mainly of value and duration, through the so-called contractual additives. The objective of this article is to analyze the occurrences of the value and duration additives in the construction contracts carried out by UFTM and IFTM since their creation, with emphasis on the different sizes of the constructions, performing statistical analysis, and comparing results between the institutions. These institutions were chosen due to their participation in the expansion and adaptation of the physical infrastructure of the federal educational institutions by the Federal Government and, also, because they are located in the same geographic region. In order to collect the data, the documentation of the construction contracts were consulted. After analyzing the results, it was observed that as the size of the new constructions increased in the UFTM, statistically, the percentage average value additive was higher. It was also verified that the percentage averages of the duration additives of medium and large-size construction of both institutions are statistically equal. Through the analysis of the main causes of construction contract additives, managers can make more effective decisions, aiming to reduce the number and value of contracts additives, since they impact not only the planning and execution of the contracts, but also the budget of the institutions.

**Keywords:** Public Constructions. Additive Value. Additive Deadline. Causes.

## RESUMO

A obra pública promove grande movimentação de recursos e constata-se o relato frequente, tanto pela mídia comercial quanto pela literatura acadêmica, de alterações durante sua execução, principalmente de valor e de prazo, através dos aditivos contratuais. O objetivo deste artigo é analisar as ocorrências desses aditivos nos contratos das obras realizadas pela UFTM e pelo IFTM desde suas criações, com destaque para os diferentes portes das obras, realizando análise estatística, e, por fim, fazendo comparativo entre os resultados. Estas instituições foram escolhidas por terem recebido parte do investimento para a expansão e a adequação da infraestrutura física pelo Governo Federal e por se situarem na mesma região geográfica. Para a coleta dos dados, foi realizada consulta aos processos de contratação das obras realizadas pelas instituições. Após a análise, observa-se que à medida que aumentou o porte das construções novas na UFTM, estatisticamente, maior foi a média percentual do aditivo de valor. Verificou-se também que as médias percentuais de aditivo de prazo das obras de médio e grande portes do IFTM e da UFTM se apresentarem estatisticamente iguais. Através da análise das principais causas de aditivos, busca-se auxiliar os gestores a tomarem decisões mais efetivas para reduzir a incidência dos aditivos, já que trazem impacto negativo tanto para o planejamento das obras quanto para o planejamento e execução orçamentária.

**Palavras-chave:** Obra Pública. Aditivo de Tempo. Aditivo de Prazo. Causas.

## **1 INTRODUCTION**

The business derived from public sector represents a large portion of the entire construction business in Brazil. According to the annual construction sector survey conducted by Instituto Brasileiro de Geografia e Estatística (IBGE, 2012 a 2016) there was an investment of R\$ 556.7 billions (~ USD 140 billions) in construction works and/or services contracted by the public sector.

It is, hence, paramount to have a high quality management of these projects, assuring timely application of the public funding to reach the desired and proposed results in a best fashion, with negligible waste of funds and time. Regrettably, the public works do not always work this way.

The design of construction projects with imperfections and/or flaws provoke the occurrence of contractual amendments, either regarding completion schedules (delay of the acquisitions completion due dates of the works) or budget adjustments (raise or reduction of the estimated value for the works,) as admitted by the Brazilian Law n° 8.666/93, the law that regulates acquisitions by the Brazilian public sector.

Studies conducted by Rasmussen (2013), Bittencourt, Ferreira e Brito (2017), Ribeiro (2015), Casotte (2016) e Santos, Starling, Andery (2015) highlight the impact of these value and due date amendments on the public institutions' budget. Beside the budgetary effects, other consequences are worth mentioning. Delay for the utilization of new installations, demanding contingent actions and added costs, and effort to obtain additional resources to cover the added costs (current and capital) help drain the already stretched manpower and financial assets. These consequences generate obstacles to effective and efficient management of the application of resources and add difficulties to the execution of the core activities of the university which are constituted by teaching, researching and service extension to the society

Under this background, this paper proposes, as main objective, to study the prevalence and cited causes for contractual amendments for the construction works conducted by Universidade Federal do Triângulo Mineiro (UFTM) and Instituto Federal do Triângulo Mineiro (IFTM), which received public funding including REUNI (a large public university expansion project conducted under the tenure of then president Luiz Inácio Lula da Silva), are situated in the same geographical region and are both federally funded educational institutions.

As specific objectives, there is the statistical sampling of the contractual amendments by types (new constructions and renovations) and by size (small, medium and large) of the works, the identification of the causes for the value and due date amendments that presented the highest impact in both institution, and the comparison between the institutions and against researched literature.

The relevance of this study is in the identification and interpretation of the causes for contractual amendments in the construction works by UFTM and IFTM, subsidizing the decision makers with information that will allow a more effective and efficient planning of the works and, consequently, the success of the project with less burden for the public administration.

## **2 LITERATURE REVIEW**

Brazilian Law n° 8.666/93 (BRASIL, 1993) permits the inclusion of privilege clauses in the contracts established with public administration, as specified in some articles, such as art, 58, 65, 67, 78, and 87. Art. 65, especially, specifies the possibility of unilateral modifications, in which the counterpart firm is obliged to accept the contractual additions or subtractions according to the interests of the public administration. The established limits by the decree are up to 25% of the initial value of the contract, in the cases of construction works, services, and purchases, and up to 50% for building or equipment reformation. This is established due to the possibility of error margins in the calculations during the basic project's design phase. For contractual due date dilation, no legal limit is established, what leads to elevated numbers in this item.

Terribili Filho (2013) pinpoints that the most frequent problems in Brazilian organization's projects, either private or public, are related to time, scope, cost, and communication. Silva Junior and Feitosa (2012) complement, highlighting the importance of public works being delivered within the established due-date, the estimated costs and according to expectation and specification, to demonstrate managerial maturity.

The "Iron Triangle" is a methodology adopted for measuring the success of a project. According to this model, the three sides, representing quality, time, and cost, are equilateral and should be in equilibrium. Alteration in any side will affect the other sides. In other words, if any of the criterions suffers change, the other criterions have to adjust in order to reestablish

equilibrium. This becomes an appropriate criterion as it is the most widely accepted in the field of project management. (DUARTE ET. AL, 2012).

Despite the criticisms received by “Iron Triangle” method, due to its limitations (BERSSANETIA; DE CARVALHO; MUSCAT, 2012), the universal objective of a construction project is to complete it within due-date, budget, and simultaneously satisfying quality and other specifications (CARVALHO; DE PAULA; GONÇALVES, 2017.) As the model satisfies the basic conditions for the success of a project, despite being basic, it is the most utilized method. The preset study encloses two of the criteria considered in the “Iron Triangle”, time and cost.

Esteves and Falcoski (2013) point that problems occur frequently along the process in Brazilian federal universities’ projects. The authors cite problems like lack of clear scope, insufficient documents and information control, lack of communication among the agents involved, compatibility errors, and lack of critical analysis of the process and of the project. They still point out that political interests in the academic institutions, as much as, the resources acquired from research projects or other covenants further complicate the task, due to change in priorities and demands change and due to short time span for the utilization of resources.

Four studies focusing on public teaching institutions were analyzed: Santos, Starling e Andery (2015) analyzed 151 projects completed between 2009 and 2014 in the city of Belo Horizonte. From this sample, 145 demanded due-date dilation (96%) and 109 had value additions (72%); In the Universidade Federal do Espírito Santo (UFES), Casotte (2016) analyzed 69 projects including new constructions and renovations. Among them, 43 (62%) obtained cost additions; Ribeiro (2015) studied the delay index and financial amendments in 42 out of 56 construction works realized by the Universidade Federal de Goiás (UFG) from 2010 to 2014, that presented contractual amendments. Bittencourt (2015) evaluated 2804 works realized by 53 federal universities, participants of the federal university expansion program known as REUNI, during the period of 2008 to 2014.

Concerning cost additions, Ribeiro (2015) reported that the total value addition of all the contracts studied came to 24.58%, very close to the legal limit imposed by Law nº 8.666/93, art. 65, § 1º (BRASIL, 1993), or 25%. Santos, Starling and Andery (2015) reported in their study 12% cost addition for new construction works and 20% for renovation and expansion works. Whenever Casotte (2015) presented a higher average of 18.36% for new

constructions and 31.36% in renovation contracts. In the case of due-date dilation, Santos, Starling and Andery (2015) and Casotte (2016) report very similar values with 100% delays for new constructions and an increase of 126% in the due-date of renovations.

Concerning the causes presented for these additions, the cause “new necessities/services after the contract signing” is coincidentally the most common cause cited in the studies of Bittencourt (2015), and Santos, Starling and Andery (2015) for value additions. Other commonly cited causes were “identification of underestimated service quantity in the project,” “unseen unpredictable foundation works and technical adjustments to the project.” For the due-date dilation, Santos, Starling, and Andery (2015) and Casotte (2016) obtained as the main causes “unrealistic duration of the contract,” “lack of compatibility between projects and work stops” and “pace reduction due to rainfalls.”

### **3 METHODOLOGICAL PROCEDURES**

According to Gil (2008), this work involves a research classified as explanatory, since it has as basic objective the identification of the factors that determine or contribute to the occurrence of a phenomenon, aiming for deeper comprehension of the reality.

In order to collect data on construction contracts, documental research was applied, as the materials used in the research did not receive any analytical treatment (GIL, 2002). According to Gil (2002), this type of research, which is based on documents, is important not because it definitely responds to a problem, but because it provides a better vision and understanding of the problem.

For the sample selection, the processes with the subject related to the infrastructure works carried out in the institutions were identified, through computerized consultation in the Government Purchasing Portal. The search in the portal, which has free access, was done using the UASG (Administrative Unit of General Services identification) of each institution and their respective campuses, in accordance with the period delimited for the study.

From this universe, analysis was realized to identify whether there were contractual modifications through contractual amendments. Moreover, the amendments were identified, classified and put in hierarchical order according to the causes of the amendments, due-date (or term) or value. For such, the contractual processes were properly registered with the data about their respective amendments, when it was the case.



In the data analysis, a quantitative study was conducted previously to verify the frequency of infrastructure works with and without contractual changes, and the value and due-date impacts of the contractual amendments in the two institutions. A statistical classification according to the type and size of the projects was also conducted. Afterward, a qualitative-qualitative study was carried out, identifying and classifying the main causes of the amendments, establishing the incidence of each cause in the universe of analyzed contracts.

Finally, comparisons of the results were conducted between the two institutions and with the results presented in the literature.

#### **4 ANALYSIS AND DISCUSSION OF RESULTS**

In this research, both new constructions and renovations were considered, so the works were separated by type. Each work was also classified as small, medium or large according to its contracting value. The classification was carried out according to the values of the bidding modality at the time of the contracting and execution of the works, following the established in art. 22 of Law No. 8.666 / 93 (BRAZIL, 1993). Thus, the small works were up to the maximum value of the invitation modality (R\$ 150,000.00, or about US\$ 38 thousand), the medium-sized works were up to the maximum value of the modality taken from price (R\$ 1,500,000.00, or US\$ 376 thousand), and, for values above this amount, were considered large works.

##### **4.1 UFTM**

Universidade Federal do Triângulo Mineiro (UFTM) was established in 2005, from the expansion of the Medical School of the Triângulo Mineiro (FMTM). Originally offering 3 undergraduate courses in the area of health sciences, the University expanded to offer, in 2019, 28 undergraduate courses, in the areas of human, exact and health sciences, as well as, engineering (UFTM, 2018).

In 2007, there was an increase in infrastructure investment as a result of the implementation of the Brazilian government Program to Support Federal University Restructuring and Expansion Plans (REUNI). This program aimed to foment the growth of public higher education (MEC, 2009). UFTM was a beneficiary of this program, according to the Restructuring and Expansion Plan of the UFTM (UFTM, 2007), receiving budgetary

resources to adjust its infrastructure. Thus, the infrastructure works studied here encompass the ones contracted and completed in the period from 2005 to 2017.

The selected UFTM contracts totaled 11. All the works were of medium and large sizes, with new constructions ranging in value from R\$ 192 thousand to R\$ 12.2 million, and renovations, from R\$ 890 thousand to R\$ 5 million.

In the works carried out by UFTM, new constructions predominated, with 7 (2 medium and 5 large), while the renovations were 4 (3 medium and 1 large). In a quantitative analysis, it was verified that, of these 11 works, all had a change in the contracted value, that is 100%, and 9 works had term (or due-date) amendment, representing 82% of contracts. One renovation and a one construction contracts did not present amendments.

Table 1 shows the incidence, percentual average and absolute value average of the UFTM value amendments among the researched processes, by type and size. The table presents also the overall view, in which all the contracts with the occurrence of this type of amendment were considered.

**Table 1** Average of the UFTM value amendments from 2005 to 2017

	AMENDMENT VALUE								
	Overall					By size			
	Total number of works	Number of sorks	Number of amendments	Average of the amendment (%)	Average value of the amendment (R\$)	Size	Number	Average of the amendment (%)	Average value of the amendment (R\$)
New construction	7	7	20	18%	R\$ 1.202.670,70	Middle	2	8%	R\$ 68.918,07
						Large	5	23%	R\$ 1.656.171,76
Renovation	4	4	10	27%	R\$ 548.226,45	Middle	3	31%	R\$ 400.182,75
						Large	1	14%	R\$ 697.526,03
Total	11	11	30	22%	R\$ 644.798,08	<b>Total</b>	<b>11</b>	-	-

Source: prepared by the author, 2018.

In general, the average value amendment in infrastructure contracts performed by UFTM was 22%, with a standard deviation of 12%.



For the new constructions, the average was 18% (representing in value R\$ 1,202,670.70), with a standard deviation of 9%, coinciding with the average percentual reported by Casotte (2016). For the renovations, there was an average of 27% (representing R\$ 548,226.45), with a standard deviation of 14%, close to that found by Ribeiro (2015). Thus, in percentual value, the renovations, and, in absolute value, the new constructions, were the main responsible for the increase in value of the UFTM contracts. It should be noted that the average value of the new constructions was twice the average value of the renovations, therefore a higher absolute change would be expected in the value amendments of those contracts.

Considering only new constructions, the average percentual of value amendments increased by 15% from medium to large. Statistically, with a significance level of 5%, the percentual increase average for new medium-sized constructions was lower than the average for the large ones. In other words, it is observed a greater precision of the basic projects of new medium sized constructions when compared to the large ones. For the renovations, the trend observed was the reverse. As the size of the renovation increased, the average value amendment fell by 17%. However, it was not possible to make the statistical comparison due to insufficient sample size. It is also noticed that the average percentage contract value increase for new large buildings was very close to the legal limit of 25%.

It is worth noting that, despite the medium-sized renovations having the largest percentage of increase in contract value, the large new constructions presented the highest absolute value amendments, R\$ 1,656,171.76 on average, implying significant budgetary impact.

Table 2 presents the incidence and the averages of the due-date amendments of the works carried out by UFTM between 2005 and 2017.

It can be noticed that 55% of the total of the works surveyed presented amendment relative to execution period, 3 new constructions and 3 renovations.

It can be observed that the new constructions were the cause of the highest value of term amendments among UFTM infrastructure contracts, both in absolute value (225 days) and in percentage (117%). The percentage of new constructions with term amendments were close to the value reported in the literature by Santos, Starling and Andery (2015), 101%, and Casotte (2016), 100%. However, the percentage relative to renovations was considerably lower than the ones reported by the same studies, that is, 125 % and 126%, respectively.

**Table 2** Average of the amendments for the period of execution and validity of the UFTM from 2005 to 2017

	DUE-DATE AMENDMENT												
	Total number of construction	EXECUTION									VALIDITY		
		Overall				By size					Amount	Average of the amendment (%)	Average of the amendment (in days)
		Number of Construction	Number of amendment	Average of the amendment (%)	Average of the amendment (in days)	Size	Amount	Average of the amendment (%)	M Average of the amendment (in days)				
New construction	7	3	15	117%	225	Middle	1	175%	210	0	-	-	
						Large	2	88%	233	5	39%	175	
Renovation	4	3	06	51%	134	Middle	2	49%	127	2	109%	291	
						Large	1	55%	149	1	32%	118	
Total	11	6	21	83,9%	180	<b>Total</b>	<b>6</b>	-	-	<b>8</b>	-	-	

Source: prepared by the author, 2018.

As shown in the table, the percentage of renovations with occurrence of amendment related to execution period was greater than that presented by the new constructions. When the medium-sized works were observed, 60% registered this type of amendment (from a total of 5 works of this size that had amendments).

The overall absolute average of the due-date amendment in the works carried out by UFTM was also lower than that found in the literature. Among those that presented this type of amendment, the average increase was 83.9%, corresponding to 180 days, with standard deviation of 53%.

Considering the causes that generated the amendments for the works carried out by UFTM between 2005 and 2017, it is observed that 60% of these had the contractor as a motivator.

Regarding the causes presented in the requests for amendment value, 93% of them relate to three more frequent ones: inclusion of services, requested by the contractor, not foreseen in the project (39%), adjustments in the projects and / or in the budget worksheet requested by the contractor (34%), and monetary correction of prices (20%). Regarding the causes of amendment related to the period of contract, 77% of the amendments are related to five main causes, which are: stoppage / decrease of the work rhythm due to the rainy season (22%), adjustments in the projects and / or in the budget worksheet requested by the

contractor (13%), execution of additional services (13%) and financial difficulty of the contractor (13%).

The causes related to inclusion / exclusion of services and changes in the projects, such as "inclusion of services, requested by the contractor, not foreseen in the project " and "adjustments in the projects and / or in the budget worksheet requested by the contractor" account for 73% of the amendments related to value and 16% of the due-date amendments, an aspect that requires attention in future planning.

In comparison with the literature, the cause "inclusion of services, requested by the contractor, not foreseen in the project " coincides with the one found by Santos, Starling and Andery (2015) as the main cause for occurrence of value amendment. In relation to the causes for the term amendment, "shutdown / decrease of the rhythm of the work due to the rainy season" and "adjustments in the projects and / or in the budget worksheet requested by the contractor" are compatible with the main causes reported by Casotte (2016).

#### 4.2 IFTM

The Instituto Federal do Triângulo Mineiro (IFTM) was created by Law No. 11,892, from December 29, 2008, established by the integration of the Federal Center for Technological Education of Uberaba and the Federal Agrotechnical School of Uberlândia. Subsequently, new campuses were created linked to this University, currently totaling 9 (nine): Advanced Uberaba Technological Park, Advanced Campina Verde, Ituiutaba, Paracatu, Patos de Minas, Patrocínio, Uberaba, Uberlândia and Uberlândia Centro.

In consultation at the Government Procurement Portal site, it was possible to access the contract data of the current budget units, corresponding to each campus, as of 2010, establishing the time-cut of research of the contracted and completed works of this institution from 2010 to 2017.

Of the total number of finished works, 24 new constructions were surveyed, or 63% of the total, and 14 were related to renovations. Among the new constructions, 4 are small, 18 are medium and 2 are large. Among the renovations, 7 are small, 6 medium and 1 large. It is worth noting the predominance of medium sized works carried out by IFTM, that is, the ones ranging from R\$ 150,000.00 to R \$ 1.5 million in the period from 2010 to 2017, with 24 works, representing 63% of the total.

Among the 38 IFTM infrastructure works surveyed, 32 presented contractual amendments, representing 84%. Among those, 17 showed a change in the contracted value, that is, 45%, and 30 works had a due-date amendment, representing 79%. It is noteworthy that 4 works (11%) had other contractual changes, such as changes in contract or project clauses, alteration of the contractor's address, which were not the object of study, as they do not imply changes of value or term of the contract.

The incidence of amendments by type of work was 83% in new construction contracts, and 86% in renovations. Of the total of 24 new constructions, in 9 had value amendments, that is, 38%, and 18 had due-date amendments (75%). Among the 14 renovation works, 57% presented value amendments, and in 12 there was a term amendment (86%). It is thus observed that the renovations were more prone to the occurrence of amendments than the new constructions.

Table 3 summarizes the incidence and averages of the value amendments related to the IFTM surveyed contracts.

**Table 3** Average of the IFTM value amendments from 2010 to 2017

	Total number of construction	AMENDMENT VALUE							
		Overall				By size			
		Number of Construction	Number of amendment	Average of the amendment (%)	Average of the amendment (R\$)	Size	Amount	Average of the amendment (%)	Average of the amendment (R\$)
New construction	24	9	10	9%	R\$ 102.040,83	Small	1	9%	R\$ 8.006,33
						Middle	7	8%	R\$ 38.461,33
						Large	1	17%	R\$ 641.132,59
Renovation	14	8	14	12%	R\$ 89.062,29	Small	2	19%	R\$ 16.174,19
						Middle	5	11%	R\$ 97.917,13
						Large	1	6%	R\$ 190.564,35
<b>Total</b>	<b>38</b>	<b>17</b>	<b>24</b>	<b>11%</b>	<b>R\$ 95.933,28</b>	<b>Total</b>	<b>17</b>	-	-

Source: prepared by the author, 2018.

During the eight-year period surveyed, considering the IFTM infrastructure work contracts that presented value amendments, the average of percentual value increase was 11%, corresponding to R\$ 95,933.28, with a standard deviation of 9%.

Of note are the medium-sized works, in which there was a predominance of amendments, accounting for 71% of total works with value amendments, or 12 out of 17, with 7 new constructions and 5 renovations.

Renovations, in percentual values, and new constructions, in absolute terms, were responsible for the largest increases in the value of IFTM contracts. At the significance level of 5%, the mean percentual value amendment for small and medium sized renovations were not significantly different ( $t_{\text{calculated}} = 0.515$  and  $t_{\text{critical}} = 12,706$ ). That is, the average percentage of amendment value for the IFTM renovations is independent of the size of the work. The other statistical comparisons between the size of the works were not possible due to insufficient sample.

As showed in Table 3, there is a tendency for the average percentual value of the amendments to increase as the size of the new constructions increases. For renovations, the trend is the reverse, as the size of the renovation increases, the average percentage of value amendment decreases. However, when considering the absolute values for the renovations, the trend is reversed, in which the percentages 19%, 8% and 6% correspond, respectively, to R\$ 16,174.19, R\$ 97,917.13 and R\$ 190,564.35. The values of the small and medium-size renovations are higher than the averages of the value amendments of the new constructions (R\$ 8,006.33 and R \$ 38,461.22).

As for the averages found, it is possible to notice that the University showed lower increases of value than those found in literature by Santos, Starling and Andery (2015), or 12% for new constructions and 20% for renovations, by Ribeiro (2015), 24.58% for the constructions, and by Casotte (2016), 18.36% for new buildings and 31.36% for renovations. The percentual averages of value increase are within the limits established by Law 8,666/93, or 25% for new works and 50% for renovations.

Table 4 shows the averages of the amendments for both the execution and validity of the infrastructure works carried out by IFTM between 2010 and 2017.

**Table 4** Average of the period of execution and validity amendments for IFTM from 2010 to 2017

	DUE-DATE AMENDMENT											
	Total number of construction	EXECUTION					VALIDITY					
		Overall				By size						
		Number of Construction	Number of amendment	Average of the amendment (%)	Average of the amendment (in days)	Size	Amount	Average of the amendment (%)	M Average of the amendment (in days)	Amount	Average of the amendment (%)	Average of the amendment (in days)
New construction	24	18	68	159%	210	Small	3	99%	61	0	-	-
						Middle	14	168%	202	8	152%	446
						Large	1	216%	778	1	202%	1060
Renovation	14	12	77	179%	257	Small	5	118%	75	1	131%	236
						Middle	6	243%	413	5	133%	453
						Large	1	98%	234	1	320%	1669
<b>Total</b>	<b>38</b>	<b>30</b>	<b>145</b>	<b>167%</b>	<b>229</b>	<b>Total</b>	<b>30</b>	-	-	<b>16</b>	-	-

Source: prepared by the author, 2018.

The average percentual increase of execution period in the works carried out by IFTM that presented this kind of amendment was 167%, that is, the work took more than double the period initially estimated, an increase that corresponds to 220 days in absolute value. The standard deviation is 159%, which shows a high amplitude of term amendment value among the works in the sample.

It is observed that a greater number of new constructions presented amendment of term of execution when compared to renovations (one third of the works), although, in percentual value, more renovation contracts had term amendments. On the other hand, the renovations were the cause of the longest amendments in IFTM infrastructure work contracts, both in absolute and in percentual values.

Considering the size of the works, medium-sized works stood out, representing 67% of the total works with this amendment type. The large works presented the least number of occurrences of term amendment, although they represent a smaller portion of the sample.

Comparing the average due-date amendment values to the ones reported in the literature, IFTM presented higher averages than Santos (2015), 101% for works in general, and Casotte (2016), 100% for new buildings and 126% for renovations.



Although there is an apparent tendency for percentual value of term amendments to increase as the size of the new constructions increases, statistically, the mean of new small and medium-sized constructions and the average of the large size renovations did not differ significantly, at a significance level of 5%. The other comparisons between work sizes were not possible due to insufficient sample.

The medium-sized works, which represent the larger portion of the surveyed works, were also presented higher occurrence of amendments, both time and term.

After analyzing the causes presented for the occurrence of amendments, it was noticed that a small number of causes is responsible for high percentage of amendments. For value amendments, the four more frequent causes represent 86% of the occurrences, and for the term amendments, the first five causes account for 73% of the amendments.

The four main causes for the occurrence of value amendments were: inclusion of services, requested by the contractor, not foreseen in the project (33%), adjustments in the projects and/or in the budget worksheet at the request of the contractor (27%), materials/services (13%) and technical improvement in the project at the request of the contractor (13%). The main causes presented for the term amendments were: bureaucratic problems external to the contractor (28%), bureaucratic problems internal to the contractor (14%), work stoppage / slowdown due to rainy season (14%), delay in delivery of material by contractor supplier (10%) and execution of additional services (7%).

The main causes of value amendments and two of the main causes of the term amendments were motivated by the contractor and / or related to the initial projects. This makes it possible to conclude that it is important to improve the internal initial part of the contracting process, that is, the preparation of the infrastructure work projects by the institution.

The causes of the term amendment "bureaucratic problems internal to the contractor" and "execution of the additional services", which represent 21% of the amendments, allow to infer that the activities of the University are causing delay in the fulfillment of the previously established schedule, being relevant to consider reviewing the internal processes.

Compared to literature, the first most related cause for the value amendments, "inclusion of services not predicted" coincides with the main causes presented by Santos, Starling and Andery (2015) and Ribeiro (2015). "Bureaucratic problems internal to the contractor" (29%) and "Stalling / slowing down of the work due to rains" (14%) coincide with

the main causes of the term amendment reported by Santos (2015) and Casotte (2016), respectively.

#### 4.3 COMPARISON BETWEEN UFTM AND IFTM

After analyzing and discussing the results related to each institution, a comparison will be made between them. This comparison is justified as the sample period is similar for both institutions, both are in the education sector, both received financial investments from the Federal Government for expansions and adjustments in their infrastructure and both are located in the same geographic region.

As reported, 11 works were analyzed in the UFTM and 38 in the IFTM, that is, the number of contracts for UFTM was 71% smaller, although the UFTM works were all medium and large sized, representing a larger total investment in the period.

It was verified that the institutions adopt different strategies when contracting infrastructure works. UFTM chooses to carry out the small works by the institution's own staff, without contracting out the service, which is why the University does not present works of this size in the sample. IFTM outsources all types of infrastructure works, presenting 29%, 63% and 8% of small, medium and large-sized works, respectively.

In relation to the occurrence of amendments, UFTM presents a higher percentage as compared to IFTM. Statistically, at the 5% level of significance, UFTM presents more works with amendments than IFTM. Compared with the literature, with the same level of significance, more UFTM and IFTM works presented value amendment than the value reported by Santos, Starling and Andery (2015). As for the term amendments, the two institutions presented the same proportion of contracts with change in deadline, at a level of 5% of significance. However, when the level of significance is modified to 10%, UFTM presents more works with this kind of amendment than IFTM. That is, it can be affirmed that the UFTM presents a higher percentage of works with amendments of value and term than IFTM.

Table 5 presents a comparison of the average percentual amendment values between the two institutions. In the table, the hypothesis tested,  $H_0$ , is "means are equal", at a significance level of 5%.

**Table 5** Comparison between the percentage means of the IFTM and the UFTM - Value amendment

Comparison		t calculated	t critic	Result
General		-2.46655378	2.1098155778	Rejected Ho.
Type	New construction	-2.216567632	2.262157163	Accepted Ho.
	Renovation	-1.57596128	2.570581836	Accepted Ho.
Size	Small	-	-	Insufficient sample
	Middle	-1.56406005	2.570581836	Accepted Ho.
	Large	-1.454127206	4.,30265273	Accepted Ho.

Source: prepared by the author, 2018

It is verified that, statistically, the mean percentage of UFTM was higher than that of IFTM. Therefore, UFTM presented higher percentual and absolute values, representing greater financial impacts to the institution than those perceived by IFTM.

When considering the type of work, statistically, the value amendments of the renovations and new constructions between the UFTM and the IFTM were not significantly different, as observed in Table 5, although the new constructions presented the calculated t and the critical t very close in value. It is also observed that, when considering the absolute values, the new constructions of UFTM stand out. These showed the highest average, in the amount of R \$ 1,202,607.70, since there is a predominance of large new buildings, representing 45% of the total works carried out by the institution, against 5% of IFTM constructions.

Regarding the size, the average percentage of amendment value of the medium and large works of IFTM and UFTM did not differ, at the significance level of 5%.

Table 6 shows the comparison between the average percentages of amendment of execution period and term of validity between the two institutions, in which the hypothesis Ho is "the means are equal", at the level of significance of 5%.

When it comes to the average term amendment, at the significance level of 5%, statistically, the percentages found by IFTM and UFTM are significantly different. As for the amendment of term, it is perceived that the IFTM presented averages above the UFTM ones.

The medium-sized works stood out in the two institutions, as they presented the highest percentages of average term amendment. The UFTM had the highest average of new construction, with 175%, equivalent to 210 days, and the IFTM stood out in the renovations, with 243%, or, 413 days. At a significance level of 5%, statistically, the average percentage of term amendment for medium and large works of IFTM and UFTM are not significantly different.

**Table 6** Comparison between the percentage means of the IFTM and the UFTM- Addendum of execution period and validity

Comparation		Addendum of execution period			Addendum of validity		
		t calculated	t critic	Result	t calculated	t critic	Result
General		2,289080	2,079614	Rejected Ho.	3,217025	2,079614	Rejected Ho.
Type	New construction	0,794251	2,446912	Accepted Ho.	3,333510	2,200985	Rejected Ho.
	Renovation	2,365038	2,178813	Rejected Ho.	1,161974	2,776445	Accepted Ho.
Size	Small	-	-	Insufficient sample	-	-	Insufficient sample
	Middle	1,052056	4,302653	Accepted Ho.	0,443030	12,706205	Accepted Ho.
	Large	0,897672	4,302653	Accepted Ho.	3,732584	12,706205	Accepted Ho.

Source: prepared by the author, 2018

Comparing the causes found in UFTM and in IFTM, the two institutions coincide the two main ones for value amendments: "inclusion of services, requested by the contractor, not foreseen in the project", responsible for 39% and 33% at UFTM and IFTM, respectively, and "adjustments in projects and / or budget worksheet at the request of the contractor", representing 34% and 27%, respectively. It should be noted that these are motivated by the contractor, being related to project and/or budget worksheet inaccuracies.

For term amendments, "slowdown in work rate due to rainfall", "delayed delivery of material by contractor supplier", "performance of amended services" and "bureaucratic problems internal to contractor" coincided among the main causes for the two institutions.

In 80% of the value amendments and 39% of the UFTM term amendments, the "contractor" was the motivator of the changes. In IFTM, the contractor motivated 86% of the value amendments and 28% of the term amendments. This shows that the analysis carried out in this research is relevant in order to take measures to mitigate the causes of the amendments, since they are internal to the institutions.

## 5 FINAL CONSIDERATIONS

The main objective of the present work was to analyze the occurrences of amendments, both term and value, in the infrastructure work contracts carried out by UFTM, from 2005 to 2017, and by IFTM, from 2010 to 2017, considering also the size of the contracts.

In the two federal educational institutions analyzed, UFTM and IFTM, it was found that most of the works were presented contractual amendments, value and / or due-date changes. This demonstrates that it is necessary to review the predicted cost and / or the due-date of the works carried out by the institutions. We must, however, analyze how beneficial this is, since these changes bring impacts that can compromise, at different levels, the efficient use of resources both in institutional and budget planning.

It is important to note that all the UFTM contracts presented value amendments, and although they presented a percentage average below that presented in the literature and below that allowed by law, the average absolute value addition was above R\$ 540 thousand. On the other hand, IFTM showed a higher incidence of term amendments with higher averages values. Although they do not reflect financial disbursement in the work immediately, they can indirectly cause impacts on the budget with other expenses arising, such as the need to extend the rent of alternative installations, as well as in research, extension, teaching and administrative activities that are planned to be housed in the area under construction or renovation.

The main causes of the value amendments and some causes of delays were motivated by the contractor and due to changes in the projects. The factors that generated these project changes were not analyzed in this study. However, some of them may be mentioned that might have contributed to the need to modify the projects after the beginning of the works. It is possible to point out the lack of time for the development of the projects, due to sudden and unforeseen changes in the availability of funds provided by the Federal Government, to political pressures, to changes in the teams involved in the projects and new demands presented by the Administration (ESTEVEES, FALCOSKI, 2013).

Since the contractor is the main motivator for the additions, it is relevant and possible for the institutions to review the elaboration of their projects in order to improve the execution of the works and try to minimize the influence of the mentioned factors. This study aims to help managers in their decisions in the use of public resources applied in infrastructure works, aiming a most effective application, by disclosing a panorama of the incidence and causes of amendments in the outsourced works.

Thus, it is expected that the results will be useful in the future decisions of the managers

responsible for the infrastructure works in each institution, leading to more efficient and realistic planning.

Considering the relevance of the subject, we suggest the application of this work in other institutions to compare the results obtained, as this work was carried out using data of two public institutions, located in the same geographical area, and might be affected by the local reality.

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