

## INFLUENCE OF SCOPE MANAGEMENT IN CONSTRUCTION INDUSTRY PROJECTS

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### *INFLUENCIA DE LA GESTIÓN DEL ALCANCE EN LOS PROYECTOS DEL SECTOR DE LA CONSTRUCCIÓN*

#### **ABSTRACT:**

In the period 2008-2015, Spanish construction industry falls into a deep crisis, that loses two-thirds of its companies, drastically reduces its production, misses the majority of its workers, and decreases its contribution to Spanish gross domestic product to less than half.

At the same time, in 2015 less than a third of projects in the worldwide construction industry end without overruns and only a quarter do so on time. Both circumstances invite to research about how to acquire competencies in project management for involved agents in the construction processes, in order to improve their performance, avoiding their failure.

Project scope is the first of success dimensions, due to its globalizing nature and predictive significance, as well as for its tactical importance against changes. In this context, ISO 21500 standard meets the ideal conditions to be used as reference to model a system for project scope management that improves the construction projects performance, by adopting measures to prevent scope creep, in any of variants. Through analysis and critique of literature, those characteristics related to scope management and those related to success that generate the greatest agreement are collected. Among pre-selected features, those considered by literature as critical success factors are compiled.

Then, based on a questionnaire given to construction industry professionals in Spain, the degree of importance of each factor is calculated and, finally, a structural equation model is proposed, in which it is confirmed that projects scope management decisively influences organizations sustained success.

**Keywords:** stakeholders, scope management, critical success factors, project success, construction industry

#### **RESUMEN:**

En el periodo comprendido entre 2008 y 2015, la industria de la construcción en España cae en una profunda crisis, que hace desaparecer dos tercios de sus empresas, reducir drásticamente su producción, perder la gran mayoría de sus trabajadores y ver disminuida su contribución al producto interior bruto hasta menos de la mitad.

Asimismo, en 2015 y a nivel mundial, menos de un tercio de los proyectos del sector de la construcción, finalizan sin sobrecostos y sólo la cuarta parte, lo hacen a tiempo. Ambas circunstancias invitan a investigar en la adquisición de competencias en dirección de proyectos para los agentes intervinientes en los procesos constructivos, con el objeto de mejorar su rendimiento, evitando su fracaso.

La gestión del alcance de los proyectos, se presenta como la primera de las dimensiones de éxito, por su naturaleza globalizadora y significancia predictiva, así como por su importancia táctica frente a los cambios. En este contexto, el estándar ISO 21500 reúne las condiciones ideales para servir de referencia para modelizar un sistema de gestión del alcance que mejore las prestaciones de los proyectos, adoptando medidas que eviten su corrupción, en cualquiera de sus variantes.

Mediante análisis y crítica de la literatura, se recopilan aquellas características relacionadas con la gestión del alcance y aquellos criterios relacionados con el éxito que mayor consenso generan. De entre las características y criterios preseleccionados, se recopilan aquellos considerados por la literatura como factores críticos de éxito.

Seguidamente, a partir de una encuesta realizada a profesionales del sector de la construcción en España, se barema el grado de importancia otorgado a cada uno de los factores y, finalmente, se plantea un modelo de ecuaciones estructurales, en el que se confirma que la gestión del alcance de los proyectos influye decisivamente en el éxito sostenido de las organizaciones.

**Palabras clave:** partes interesadas, gestión del alcance, factor crítico de éxito, éxito del proyecto, industria de la construcción

## 1.- INTRODUCTION

The construction industry shows in Spain, during the period 2008-2015, a state of crisis that forces organizations to rethink their strategies for their current survival and future development of their activities. At a macroeconomic level, there are many indicators that reflect the severity of this situation:

- Production falls by 79,66% [1]
- Number of workers decreases by 65,59% [2]
- Trade turnover descends by 68,23% [2]
- Contribution to Spanish GDP reduces by 52,22%, from 10,61% to 5,07% [3]

Also concerning projects' completion [4], in 2015 worldwide:

- <31% of construction projects are completed below 110% of planned budget
- <25% of construction projects are completed below 110% of planned schedule

In this context of deep economic crisis, high failure rate in undertaken projects and increasing technical and socioeconomic complexity of construction processes [5], construction organizations need to establish a competitive advantage [6], by expanding market shares and/or creating new business areas; emerging project management as a solution, thanks to participate effectively in the interests and needs of clients and other stakeholders, ensuring the achievement of involved organizations [7].

### 1.1.- PROJECTS' SCOPE MANAGEMENT

The first step in the implementation and control of a project management standardized methodology in the construction industry organizations, as a framework for the establishment of policies on projects, consists of managing their scope [8], establishing objectives, setting limits, specifying deliverables and ensuring the understanding of roles in the construction processes and of derived actions from agents responsibilities [9].

From the point of view of the construction industry organizations that develop projects, scope management defines them, providing, with the stakeholders analysis, the necessary especifications to describe the contract; agreeing requirements, restrictions, exclusions and potential solutions [10]; according the work to complete them [11]; planning, executing and controlling [12]; and, once completed, being validated and verifying deliverables [13].

Scope management considers what can be done in projects, why it must be done and how it can be done. Likewise, projects' scope has a strong relationship with major restrictions, such as time, cost, quality, risks and resources [7]; being established as a precursor variable of technical performance and generated business, playing a key role in results definition and representing the strategic mission of organizations that manage them [13].

Given the diversity of guides, bodies of knowledge, bases for competence, good practices and recommendations that are being offered by associations in project management, such as the International Project Management Association (IPMA) or the Project Management Institute (PMI), the international standard ISO 21500 [14] combines the guidelines set by them [15]:

- Provide a common language
- Get organized as a model that follows the lifecycle of projects
- Be carried out by processes
- Use concepts and needed skills to impact on performance
- Be compatible with British standards BS6079 and PRINCE2, German standard DIN69901, US standard ANSI BSR / PMI 99-001-2013, Japanese standard PMAJ P2M, Australian standard AS4915 and international standards IPMA ICB and PMI PMBOK, among others

Based on ISO 21500, as Figure 01 shows, a system for scope management is presented, including the considerations of the two most prestigious organizations in this field; PMI, with its research programs and development opportunities, and IPMA, with its humanistic vision. For its modelization, it's adopted a competences-based approach from IPMA ICB4 [16], to acquire the necessary professional competencies; and a processes-based approach from PMI PMBOK 5 [17], to provide the framework in which to apply the system processes, that are grouped into these three stages:

- During project planning:
  - Scope design, involving the project manager with key stakeholders, which consists of the processes of requirements agreement and scope definition
  - Scope development, involving the project manager and the management team, which consists of the process of work structuration
- During project execution and control:
  - Scope supervision, involving the project manager and the management team with project implementation team, which consists of the processes of scope control and changes integration

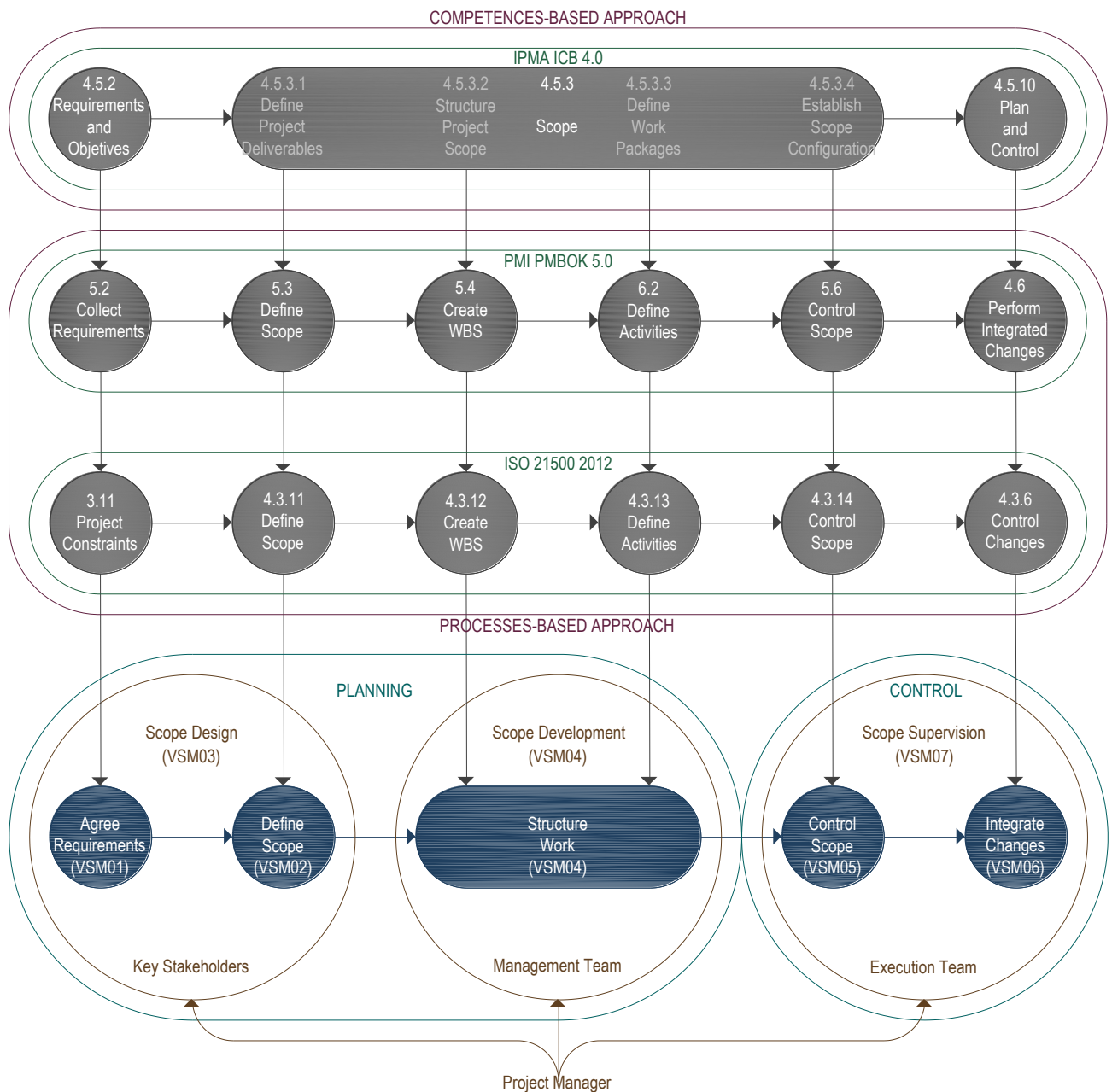


Figure 01. Development of a scope management system based on the most important international standards

Design scope stage analyzes and converts stakeholders' needs and expectations into requirements, in order to meet project objectives, for what to try [16, 17]:

- Define both work and deliverables
- Analyze requirements providers
- Study agreed requirements impact
- Examine assumptions and constraints
- Include both intermediate and final deliverables characteristics, specifications and acceptance criteria, preliminary cost estimates and schedule milestones

Development scope stage organizes and defines the work to be performed, for what to consider [16, 17]:

- Communicate what to do and how to deliver the results
- Identify both activities and results
- Consolidate requirements
- Facilitate the assignment of roles and responsibilities
- Avoid the omission of tasks and their duplicity
- Guide the realization of both budget and schedule
- Facilitate impact analysis and communication
- Integrate changes control
- Reference improvement processes
- Document learned lessons

Supervision scope stage ensures objectives compliance and expected goals achievement, for what to attempt [16, 17]:

- Measure performance
- Identify variations
- Take both preventive and corrective actions
- Influence factors that cause scope changes
- Analyze requested changes impact, studying its conditions and traceability
- Ensure agreed changes are properly processed
- Review deliverables
- Get a formal acceptance

## 1.2.- ORGANIZATIONS' SUSTAINED SUCCESS

The investigation of critical success factors in the construction industry is a general strategy of organizations to address their challenges [18] and improve the efficiency of their processes [19], in order to maintain and increase their competitiveness [20]; ensuring that stakeholders expectations are adequately satisfied and that their future demands are properly treated [21].

Scope management is critical to the successful implementation of projects [22], as well as to satisfy the organization, business, customers and other stakeholders [10]. However, projects success is influenced by a wide range of additional factors, which, if neglected, damage their results [23]. Furthermore, integral success criteria must reflect the diverse interests and perspectives of stakeholders [24], leading to a multidimensional approach [25].

Principal dimensions to judge the resulting total success [26], are:

- Project, including its main constraints (scope, cost, time, quality, risk and resources)
- Customers, including their satisfaction and real use of project results
- Organization, including its market positioning and generating profits

In relation to the success of the project, consisting of the achievement of the agreed objectives [20], completing the defined scope and generating the committed deliverables [8], with the participation of stakeholders [27], two components are identified [10]:

- Project management success, focusing on processes and how the project is implemented
- Results success, based on the effects of the resulting project products and/or services:
  - Compliance with strategic objectives (added value, project goals)
  - Satisfaction of stakeholders' needs (efficiency, processes quality)

Project management is a complex undertaking, in which is necessary to attend many variables and be alert to early signs of problems, using tools for monitoring, allowing a proactive response [28]. In this regard, activities to ensure that project management practices are effective and efficient, are directly related to project management functions [29]:

- Anticipate potential conflicts arising from stakeholders' needs and expectations
- Understand the root cause of previous problems, to prevent their recurrence
- Provide all necessary resources, including those for improvement, innovation and learning
- Monitor, measure and analyze
- Keep stakeholders informed, getting them their commitment
- Develop, update and meet objectives, including setting deadlines to achieve them
- Review management system and its processes, updating them if necessary
- Ensure that results are consistent with strategy

Organizational project management maturity lies in its capacity to success consistently. According to this base, as ISO 9004 determines [30], organizations' sustained success is achieved thanks to its ability to meet stakeholders needs and expectations, including customers, in the long term and in a balanced way, through learning, efficient management and environment awareness.

## 2.- METHODOLOGY

Investigation aims to demonstrate the influence of project scope management on the success of the project itself, in generated business and in the organization that undertakes it. To do this, project scope management defines and controls what is included and excluded from it, checks the full completion of work and prevents aggregation of work not agreed, through changes management, from identifying stakeholders, determining needs to cover, defining objectives and gathering requirements.

Used methodology is the observation by questionnaire. For the collection and subsequent statistical processing of data, the free platform Google Forms is used. Based on the analysis of the received responses, through their discrete and individual quantification, knowledge under study is characterized and the relationships among interest variables are statistically contrasted. For the study, a Likert specific scale of five items 1-5 is adopted, which allows to measure attitudes and determine the degree of compliance with the proposed respondents claims, helping professionals in motivating their opinions, to capture their intensity towards those statements.

In the selection of questions, a structured two-step process is followed:

1. As primary sources, from literature, an extract is performed:
  - Characteristics of projects' scope management
  - Criteria (set of principles or standards used to judge a series of events) for organizations' sustained success
2. As secondary sources, from literature, an extract is performed:
  - Critical success factors (characteristics, issues or variables that cause an essential and direct impact) in projects' scope management
  - Critical success factors in projects, business and organizations

After the analysis of the sources of information for the questionnaire preparation, in Tables 01a-01b, are summarized the resulting issues, in which respondents are asked, in the context of the construction industry, about the degree of importance given to each of items that are exposed:

Codes	Questionnaire items	Characteristics and criteria	Factors
<b>Questions about project scope design:</b>			
SM01	Getting information from stakeholders and achieving their involvement	[16, 17]	[10, 13]
SM02	Studying stakeholders' needs and expectations and legal provisions	[16, 17]	[11, 13]
SM03	Collecting and processing requirements into technical and functional specifications	[16, 17]	[5, 31]
SM04	Analyzing requirements potential impact and prioritization	[16, 17]	[5, 11]
SM05	Getting customer participation, commitment and acceptance	[16, 17]	[5, 13]
SM06	Defining project limits and description of work to be done	[16, 17]	[5, 13]
SM07	Analyzing constraints and considering assumptions	[16, 17]	[10, 13]
SM08	Agreeing definition of deliverables and milestones	[16, 17]	[13, 31]
<b>Questions about project scope development:</b>			
SM09	Sizing the project and organizing its planning	[32, 33]	[5, 13]
SM10	Dividing work in a structured way	[32, 33]	[5, 12]
SM11	Coordinating project activities in a effective way	[7, 8]	[12, 13]
SM12	Checking the reliability and integrity of project planning	[7, 8]	[12, 13]
<b>Questions about project scope supervision:</b>			
SM13	Using a project scope control system	[14, 17]	[11, 13]
SM14	Involving the client during project implementation	[16, 17]	[5, 13]
SM15	Establishing metrics for calculating project performance indicators	[16, 17]	[13, 31]
SM16	Evaluating project scope regularly and making contingency plans	[8, 16]	[5, 13]
SM17	Getting performance according to available capacities	[8, 16]	[5, 31]
SM18	Validating and verifying the deliverables quality	[14, 17]	[11, 13]
SM19	Implementing a project changes integrated control system	[17, 34]	[5, 35]
SM20	Eliminating the resistance to change	[16, 34]	[13, 35]

Table 01a. Critical success factors for projects' scope management

Codes	Questions about project success:		
TS01	Fulfilling agreed requirements with project results	[23, 24]	[10, 11]
TS02	Prospering customer thanks to project benefits	[18, 24]	[13, 19]
TS03	Controlling the integrity of project baselines	[23, 24]	[10, 11]
TS04	Guaranteeing project profitability and productivity	[18, 24]	[13, 19]
<b>Questions about context success:</b>			
TS05	Satisfying the organization	[24, 27]	[5, 20]
TS06	Satisfying the project manager and the management team	[18, 24]	[5, 20]
TS07	Satisfying the project execution team	[18, 24]	[5, 10]
TS08	Satisfying other stakeholders	[18, 27]	[5, 20]
TS09	Satisfying the customer	[24, 27]	[10, 13]
TS10	Satisfying final users	[18, 27]	[13, 20]
TS11	Contributing to new projects	[18, 24]	[20, 26]
TS12	Ensuring business continuity	[18, 24]	[20, 26]

Table 01b. Critical success factors for organizations' sustained success

Then, once the questionnaire is full defined, it is distributed by the following media:

- Firstly, to working groups, through social network LinkedIn:
  - AECMA Asociación Española de Construction Management
  - AEGC Asociación Española de la Gestión de la Construcción
  - AEPDP Asociación Española de Profesionales en Dirección de Proyectos
  - CCPM Construction Certified Project Managers PMP
  - CMAS Construction Management Association of Spain
  - DIP Dirección Integrada de Proyectos
  - DP Directivos y Profesionales de Proyectos de Edificios e Infraestructuras
  - ISO 21500 Project Management
  - SEARCH&DRIVE Profesionales de la Arquitectura y la Ingeniería
  - TL Técnicos de la Arquitectura, Construcción e Ingeniería

- Secondly, through public lists of Spanish official colleges of professionals with legal attributions in the construction industry:
  - Higher Council of the Colleges of Architects of Spain
  - General Council of Technical Architecture of Spain
  - College of Road, Canal and Port Engineers of Spain
  - College of Public Works Technical Engineers and Civil Engineers of Spain
  - Higher Council of Colleges of Industrial Engineers of Spain
  - General Council of Technical Industrial Engineering of Spain
- Thirdly, thanks to professional associations:
  - AEIPRO Spanish Project Management and Engineering Association
  - PMA Project Managers Association of Andalusia
  - PMI Spanish Chapters (Balearic Islands, Barcelona, Madrid and Valencia)

### 3.- RESULTS

Once the exhibition period of the questionnaire is ended, 380 responses are received, of which 25 are rejected for not presenting respondents a demonstrable competence in project management (neither experience nor expertise). To describe the final sample of 355 individuals, a series of control questions are made, related to personal issues (gender, age and university title), with the organization in which they provide their services (size and role) and project management (specific training, professional certification and experience). Table 02 summarizes the characteristics of the sample population:

Gender																	
Units			%			Gender			Gender								
103			29,01%			Female			252			70,99%			Male		
Age																	
Units	%	Age	Units	%	Age	Units	%	Age	Units	%	Age	Units	%	Age			
13	3,66%	> 60 years	84	23,66%	46 – 60 years	228	64,23%	31 – 45 years	28	7,89%	25 – 30 years	2	0,56%	< 25 years			
University Title (multiple answers)																	
Units	%	University Title	Units	%	University degree	Units	%	University degree	Units	%	University degree						
149	41,97%	Architecture	53	14,93%	T. Architecture	7	1,97%	Road, Canal and Port E.	5	1,41%	Public Works T.E.						
61	17,18%	Industrial E.	29	8,17%	Industrial T.E.	16	4,51%	Computing E.	14	3,94%	Computing T.E.						
9	2,54%	Telecommunications E.	1	0,28%	Telecommunications T.E.	1	0,28%	Agronomics E.	2	0,56%	Agronomics T.E.						
1	0,28%	Naval E.	1	0,28%	Naval T. E.	3	0,85%	Chemistry E.	1	0,28%	Mining E.						
3	0,85%	D. in Physics	3	0,85%	D. in Mathematics	9	2,54%	D. in Business	3	0,85%	D. in Economics						
3	0,85%	D. in Environment	2	0,56%	D. in Law	1	0,28%	G. in Tourism	8	2,25%	Neither						
Role in Organization (multiple answers)																	
Units	%	Role	Units	%	Role	Units	%	Role	Units	%	Role						
117	32,95%	High Direction	47	13,24%	Program M.	150	42,25%	Project M.	37	10,42%	M. Team	111	31,27%	Technician			
Size of Organization																	
Units	%	Size	Units	%	Size	Units	%	Size	Units	%	Size						
83	23,38%	Big	46	12,96%	Medium	57	16,06%	Small	99	27,89%	Micro	70	19,72%	Freelance			
Specific Training in Project Management (multiple answers)																	
Units	%	Specific Training	Units	%	Specific Training	Units	%	Specific Training	Units	%	Specific Training						
15	4,23%	Doctorate	80	22,54%	Master	26	7,32%	University Expert	33	9,30%	University Postgraduate						
102	28,73%	In University Title	107	30,14%	Preparation for Certification	22	6,20%	Corporate Training	72	20,28%	Neither						
Professional Certifications in Project Management (multiple answers)																	
Units	%	Professional Certification	Units	%	Professional Certification	Units	%	Professional Certification	Units	%	Professional Certification						
96	27,04%	PMI-PMP	2	0,56%	PMI-ACP	2	0,56%	PMI-RMP	5	1,41%	PMI-RMP						
2	0,56%	IPMA-B	8	2,25%	IPMA-C	18	5,07%	IPMA-D	4	1,13%	PRINCE2 Foundation						
1	0,28%	APMG PMD Pro 1	1	0,28%	AENOR GP	1	0,28%	IESE PDD	230	64,79%	Neither						
Experience in Project Management																	
Units	%	Experience	Units	%	Experience	Units	%	Experience	Units	%	Experience						
42	11,83	> 20 years	116	32,68%	11-20 years	98	27,61%	6-10 years	64	18,03%	1-5 years	35	9,86%	< 1 year			

Table 02. Characteristics of the study sample population

Then, it is necessary to ensure the reliability and accuracy of the measuring instrument, in order to analyze the results from the 355 answered surveys. With a mean of 77,41% and a heterogeneity of 22,93%, the sample population commits a statistical error of 4,26%, for a confidence interval of 95,45%. It also has a reliability (internal consistency) of 94,90%, according to Cronbach test.

As a descriptive summary of the population sample, in Table 03, the mean  $\bar{X}$ , standard deviation  $\sigma$  and homogeneity  $r_{it}$  (element-corrected global correlation) of every survey question are presented, and their grouping into stages-dimensions and constructs:

Parameters	Scope Design (VSM01+VSM02→VSM03)								Scope Development (VSM04)				Scope Supervision (VSM05+VSM06→VSM07)							
	SM01	SM02	SM03	SM04	SM05	SM06	SM07	SM08	SM09	SM10	SM11	SM12	SM13	SM14	SM15	SM16	SM17	SM18	SM19	SM20
$\bar{x}$	4,437	4,372	4,034	3,868	4,310	4,318	3,887	4,194	4,048	4,155	4,270	3,865	3,879	3,589	3,775	4,146	4,093	3,763	3,837	3,927
$\sigma$	0,769	0,738	0,791	0,855	0,813	0,855	0,816	0,876	0,883	0,909	0,827	0,853	0,977	0,997	0,971	0,921	0,870	0,918	1,026	0,939
$r_{it}$	0,655	0,631	0,564	0,612	0,634	0,688	0,595	0,651	0,674	0,710	0,672	0,596	0,644	0,522	0,611	0,654	0,572	0,639	0,567	0,609

Parameters	Project Success (VTS01)				Context Success (VTS02+VTS03→VTS04)								Summary							
	TS01	TS02	TS03	TS04	TS05	TS06	TS07	TS08	TS09	TS10	TS11	TS12	VSM03	VSM04	VSM07	VTS01	VTS04	SM	TS	Total
$\bar{x}$	4,301	4,239	4,135	4,115	4,124	3,977	3,941	3,690	4,648	4,510	4,377	4,262	4,177	4,085	3,876	4,198	4,191	4,038	4,193	4,096
$\sigma$	0,782	0,841	0,859	0,893	0,796	0,867	0,938	0,914	0,622	0,786	0,787	0,841	0,839	0,880	0,967	0,848	0,876	0,911	0,866	0,898
$r_{it}$	0,615	0,615	0,629	0,632	0,607	0,501	0,372	0,364	0,532	0,554	0,588	0,660	0,877	0,846	0,867	0,826	0,818	0,957	0,656	1,000

Table 03. Descriptive statistics for scope management and total success model

Besides, in Figure 02, the importance degree of studied items is summarized:

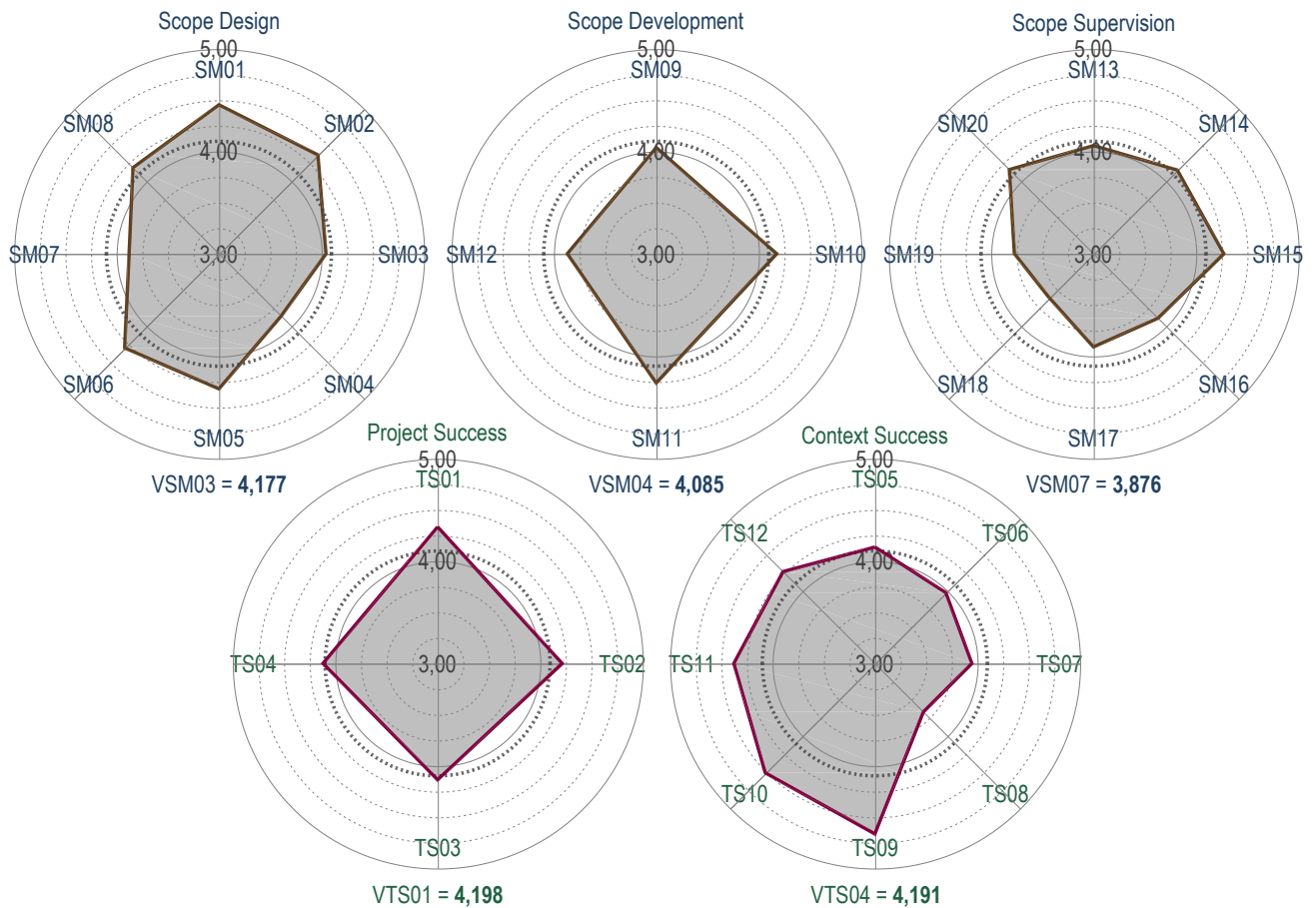


Figure 02. Importance degree of studied factors for scope management and total success



### 3.1.- EXPLORATORY FACTOR ANALYSIS (EFA)

Later, a study of the dimensionality of proposed items is performed, through an exploratory factor analysis by principal components extraction and Varimax rotation with Kaiser normalization, looking for a solution for scope management and total success constructs.

In Table 04, principal components of questionnaire items, as well as technical data to validate the EFA model, are shown (percentage of variance explained, Kaiser-Meyer-Olkin test and Bartlett's test of sphericity):

Scope Management (SM)						Total Success (TS)					
Scope Design (VSM03)		Scope Development (VSM05)		Scope Supervision (VSM07)		Project Success (VTS01)		Context Success (VTS04)			
Factor	1	2	Factor	1	2	Factor	1	2	Factor	1	2
FA01	,545	,434	FA09	0,811	0,304	FA13	0,764	0,304	FE01	0,704	0,511
FA02	,697	,376	FA10	0,837	0,099	FA14	0,857	0,099	FE02	0,798	0,304
FA03	,846	,189	FA11	0,837	0,222	FA15	0,818	0,222	FE03	0,799	0,138
FA04	,806	,216	FA12	0,699	0,444	FA16	0,586	0,444	FE04	0,766	0,239
FA05	,482	,580			0,165	FA17	0,165	0,747	FE05	0,302	0,665
FA06	,254	,779			0,465	FA18	0,465	0,583	FE06	0,133	0,761
FA07	,484	,512			0,462	FA19	0,462	0,626	FE07	0,248	0,793
FA08	,146	,825			0,179	FA20	0,179	0,827	FE08	0,305	0,731
Variance	63,707%		Variance	63,721%		Variance	64,265%		Variance	60,924%	
KMO Test	0,885		KMO Test	0,757		KMO Test	0,880		KMO Test	0,737	
Bartlett Test	1.173,938		Bartlett Test	483,649		Bartlett Test	1.165,116		Bartlett Test	358,846	
(DF)	28		(DF)	6		(DF)	28		(DF)	6	
(Significance)	0,000		(Significance)	0,000		(Significance)	0,000		(Significance)	0,000	

Table 04. Results of EFA model

Based on obtained results, exploratory factor analysis can be considered as valid, because it influences, in all studied cases, each of the following circumstances:

- Total variance explained by principal components, greater than 50%
- Measure of sampling adequacy, by Kaiser-Meyer-Olkin test, greater than or equal to 0,500
- Applicability, by Bartlett's test of sphericity, discarding the lack of correlation between items, because it presents a high Chi-square and a significance lower than 5%

Figures 03a-03b show the resulting EFA model diagram, which, based on the twenty factors for projects' scope management and the twelve for organizations' total success, the system is reduced to five and three dimensions, respectively:

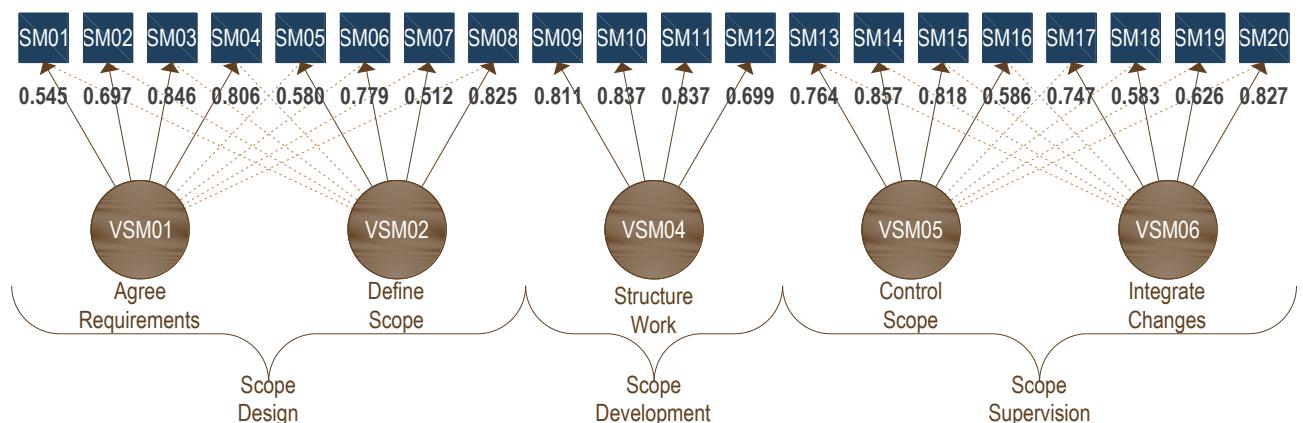


Figure 03a. Resulting diagram of EFA model for projects' scope management

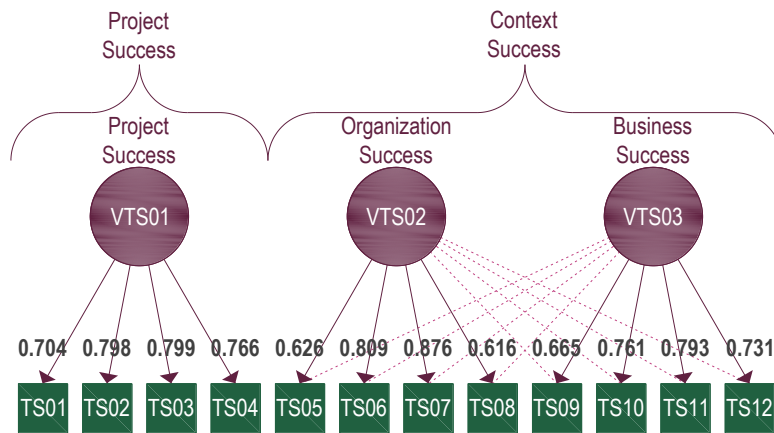


Figure 03b. Resulting diagram of EFA model for organizations' total success

### 3.2.- CONFIRMATORY FACTOR ANALYSIS (CFA)

In contrast to exploratory factor analysis, in which the construction of data does not arise a priori (number and ratio of components), confirmatory factor analysis allows greater flexibility in establishing the constructs structure, by contrast models built in advance. In this regard, CFA, performed by the method of maximum likelihood estimation, allows to contrast the EFA model, starting with the set of relationships among the factors that compose it.

To build the CFA model, items that make up every principal component (dimensions) of the EFA model are grouped in first grade latent variables (requirements agreement, scope definition, work structuration, scope control, changes integration, project success, business success and organization success) and, in cases where two components are extracted, they are grouped again, conforming second grade latent variables (scope design, scope supervision and context success). Subsequently, all variables of every construct are related to each other, forming an interrelationships structure that recognize the complexity and multidimensionality of studied constructs, both projects' scope management and organizations' sustained success.

However, the CFA model exhibits suggested adjustments, through Lagrange multipliers test, in which improvement (through modification indices), that is obtained by adding a series of covariances to errors of the theoretical model, is evaluated, being proposed in this investigation only those that meet the following conditions:

- Statistically significant operation
- Exclusive relationship among factors errors from the same variable
- Theoretical baseline justification, highlighting relationships among:
  - Information and involvement of stakeholders with their needs and expectations, project requirements and specifications
  - Project constraints and assumptions with the definition of its limits, deliverables and milestones and the work description
  - Project dimension and work structuration with planning organization and activities coordination
  - Scope control with the establishment and evaluation of metrics and indicators, preparation of contingency plans and performance achievement
  - Customer implication with deliverables acceptance, resistance to change and its integration
  - Compliance requirements and baseline integrity, prosperity, profitability and productivity
  - Satisfaction of the organization, project manager, management team, execution team and other stakeholders
  - Satisfaction of the customer and final users with the contribution to new projects and business assurance

In Table 05, main indices (chi-square fit index divided by degrees of freedom, comparative fit index, goodness of fit index and root mean square error of approximation), resulting from statistical analysis of CFA models, both the theoretical and the adjusted, for projects' scope management and organizations' total success, are shown:

Model	CMIN	DF	CMIN / DF	CFI	GFI	RMSEA
CFA Scope	578,259	163	3,548	0,885	0,848	0,085 (0,077-0,093)
<b>CFA Adjusted Scope</b>	<b>425,143</b>	<b>145</b>	<b>2,932</b>	<b>0,918</b>	<b>0,904</b>	<b>0,066 (0,058-0,074)</b>
CFA Success	183,552	51	3,599	0,926	0,924	0,086 (0,073-0,099)
<b>CFA Adjusted Success</b>	<b>78,467</b>	<b>41</b>	<b>1,914</b>	<b>0,979</b>	<b>0,966</b>	<b>0,051 (0,033-0,069)</b>

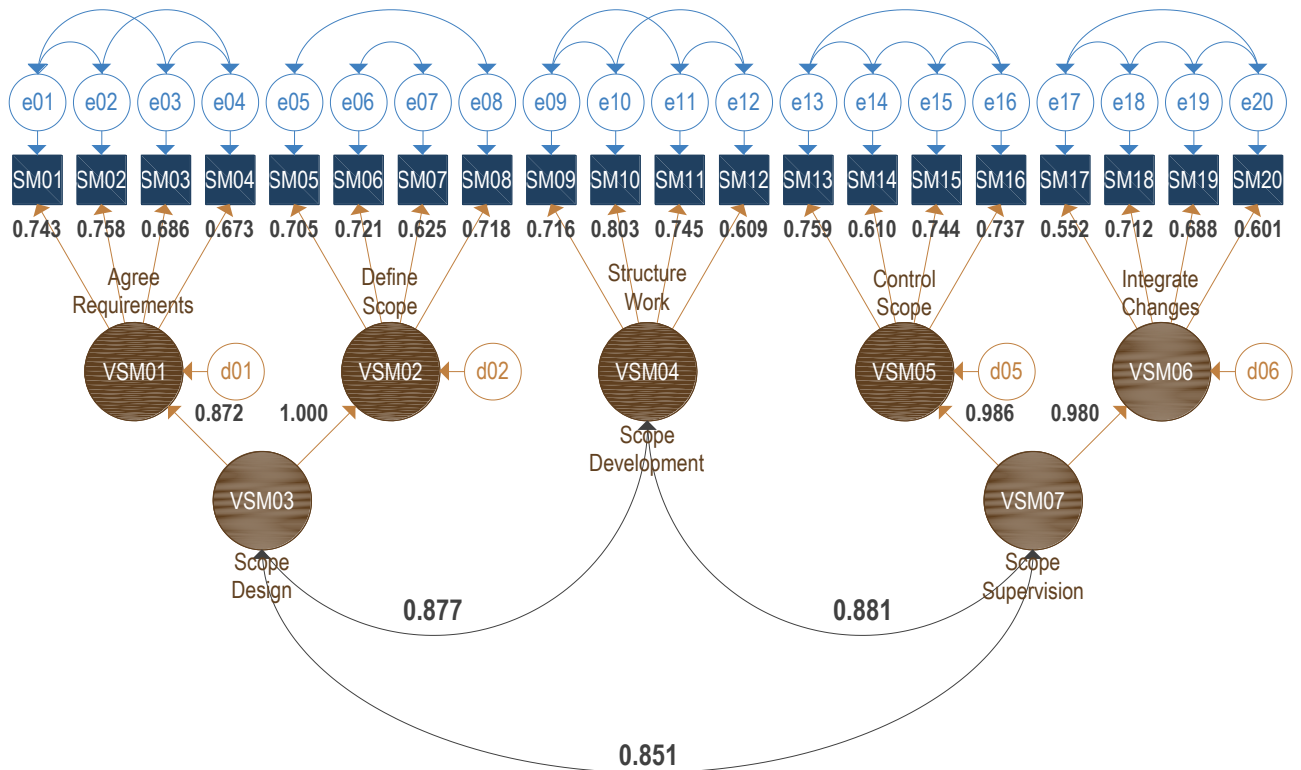
Table 05. CFA model indices

From the obtained results, confirmatory factor analysis can be validated, because in all studied cases, each of the following circumstances occur:

- CMIN/DF: Chi-square fit index (minimum discrepancy, maximum likelihood) divided by its degrees of freedom, lower than 5
- CFI: Comparative fit index, confronting the fit between the independent and the estimated model and being located between 0 and 1, higher than 0,9
- GFI: Goodness of fit index, expressing the variability explained by the estimated proposed model and being located between 0 and 1, higher than 0,9
- RMSEA: Root mean square error of approximation, predicting how the model fits the covariance matrix of population sample, lower than 8%

In Figures 04a-04b, the adjusted confirmatory factor analysis (modified according to suggestions from Lagrange multipliers test) is presented, both projects' scope management and organizations' total success:

Figure 4a. CFA model for projects' scope management



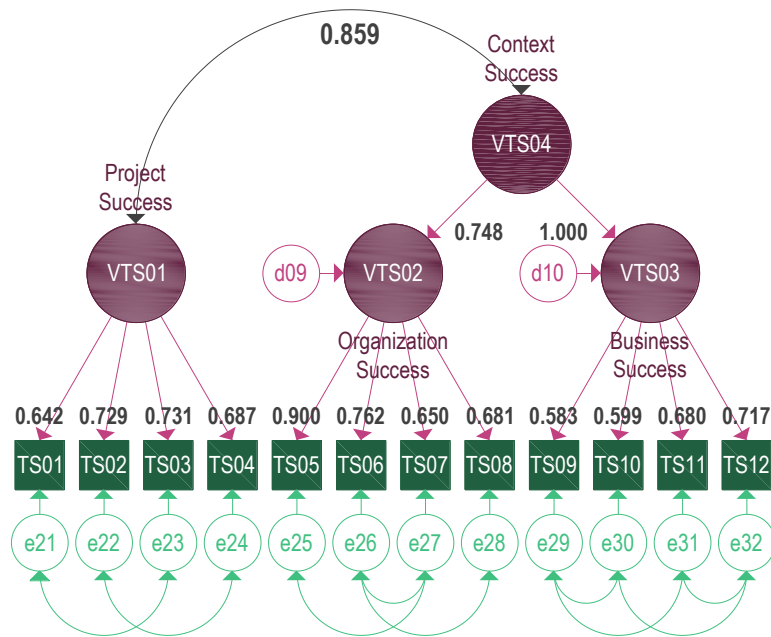


Figure 04b. CFA model for organizations' total success

### 3.3.- STRUCTURAL EQUATION MODELING (SEM)

Once CFA models are defined, it proceeds to determine a single SEM model that links them. To structure SEM model, it is necessary to establish the construction of the two main constructs, as third grade latent variables. In contrast to previous models, all parts interact with each other, forming a network of interrelations, similarly to the oblique rotation in the exploratory factor analysis.

Scores on each dimension, not only depend on the main constructs, but they are influenced by terms of (residual) errors. In this way, the constructs are free of measurement error, because these parameters are different from the variables which are associated:

- Project's scope management, composed of these dimensions:
  - Design
  - Development
  - Supervision
- Organizations' total success, composed of these dimensions:
  - Project
  - Context

Once main constructs are modeled, it is necessary to specify the relationship that binds them, as the main objective of this investigation.

In Table 06, main indices to validate the SEM model are shown (by presenting each of circumstances described in the previous section: a chi-square fit index divided by its degrees of freedom lower than 5, a comparative fit index and a goodness of fit index higher than 0,9 and a root mean square error of approximation lower than 8%):

Table 06. SEM model indices

Model	CMIN	DF	CMIN / DF	CFI	GFI	RMSEA
SEM	1190,324	452	2,633	0,874	0,853	0,068 (0,063-0,073)
<b>Adjusted SEM</b>	<b>947,211</b>	<b>424</b>	<b>2,234</b>	<b>0,911</b>	<b>0,909</b>	<b>0,059 (0,054-0,064)</b>

Figure 05 shows the SEM model that links projects' scope management with organizations' total success. The degree of relationship between main constructs, for population sample, is 84,7%, so that projects' scope management positively justifies the 71,75% of the variance of organizations' total success:

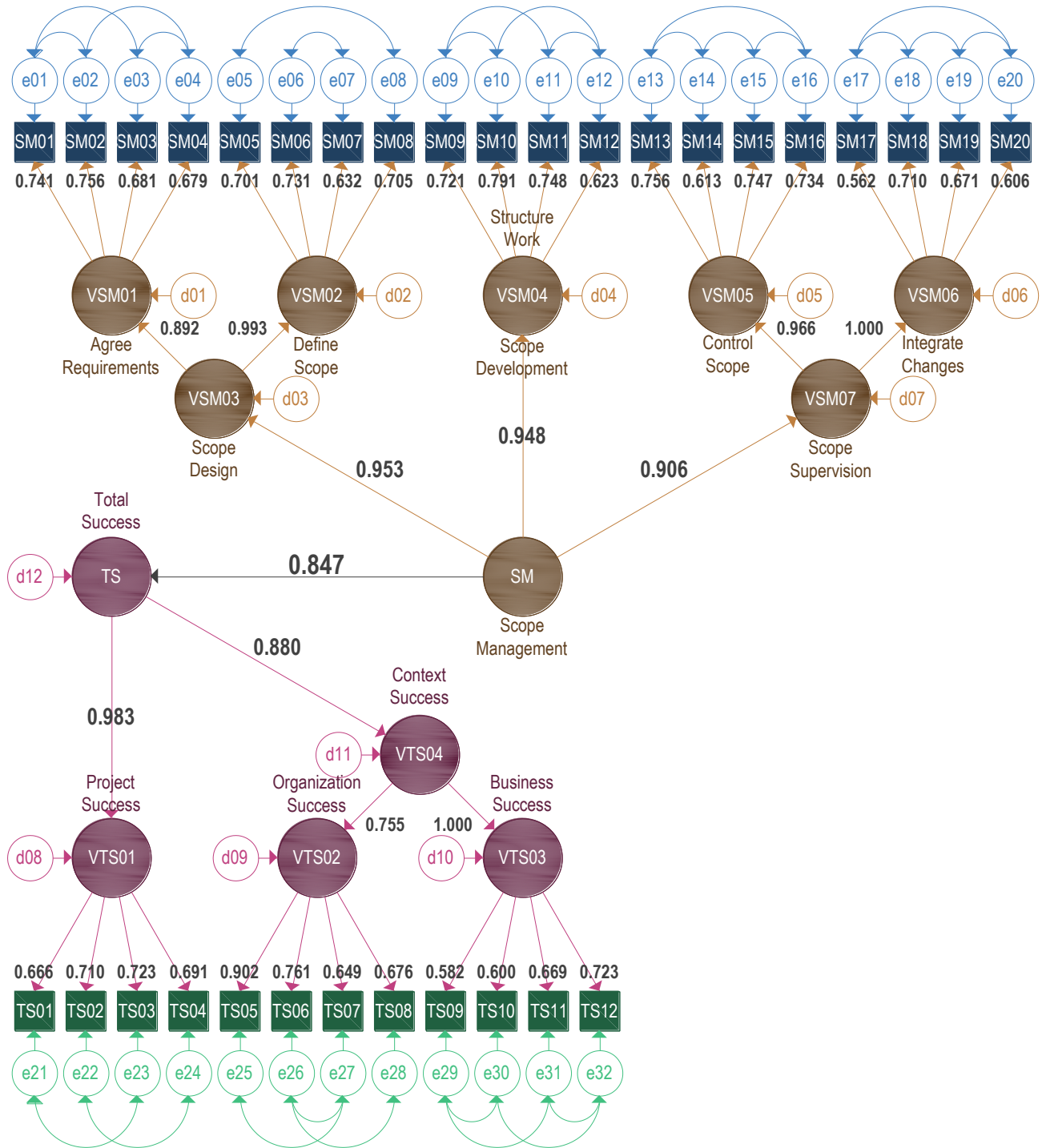


Figure 05. SEM model for scope management and total success

## 4.- CONCLUSIONS

Obtained results support the inclusion, in the modeled scope management system for total success [14, 16-17], of the characteristics [7-8, 14, 16-17, 32-34], criteria [18, 23-24, 27] and factors [5, 10-13, 19-20, 26, 31, 35] which have been proposed in this research, providing solid statistical evidences that confirm the importance of factors, dimensions and constructs raised, and their relationships, so the existence of significant implications is corroborated.

Projects' scope planning is particularly critical [7-8], both design and development stages [5, 10, 13, 31-35], because of its importance and to exercise special influence on the sustained success of organizations [18-20, 23-24, 26], so it is necessary to pay attention caring for presented items.

Definitively, in the context of the Spanish construction industry, it is confirmed that projects' scope management is presented as one of the causes of organizations' total success, this latter being the compendium of the success of projects, business and organizations themselves.

As future research lines, it is an opportunity to continue working on the establishment of structural equation models among organizations' total success and the other major restrictions in construction industry projects [7, 10, 13, 18-21, 23, 25-28, 31, 35], such as cost, schedule, quality, resources and/or risks.

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