MANAGEMENT PERFORMANCE OF CIVIL INFRASTRUCTURE PROJECTS IN EGYPT

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ABSTRACT

In the field of civil engineering, the infrastructure projects encounter more uncertainties than other building and industry projects. These uncertainties lead to high-risk potential that affect the investments need to be allocated for infrastructure, especially in developing countries. The presented study assesses the current needs in order to enhance the functioning of project management knowledge and conduct for the civil engineering projects in the Egyptian infrastructure. The assessment process was conducted through the senior engineers of the General Organization for Sanitary Drainage. The conclusions of the study stress the drawbacks in the management processes, the reasons for these drawbacks, and the recommendations to enhance the demeanor of project management capacities in this specific area. Quantitative parameters are introduced to represent the effect and interdependency of the dominant parameters affecting the management process.

الأداء الإداري في المشروعات المدنية للبنية التحتية بمصر

تشتمل مشروعات البنية التحتية على درجة أعلى من المخاطر أكثر من مشروعات المباني و المصانع. و تؤثر هذه المخاطر على الاستثمارات المطلوبة لمشروعات البنية التحتية. و تقدم الدراسة المطروحة تقييم للاحتياجات الحالية لتطوير توظيف علوم إدارة المشروعات في مشروعات البنية التحتية بمصر. و قد بنيت الدراسة على مناقشات مع مهندسي الهيئة العامة للصرف الصحي. و قد امتدت الدراسة لتشمل البيئة التي تجرى فيها مشروعات البنية التحتية و كذلك توزيع المسئوليات و الصلاحيات في هذه المشروعات. كما تضمنت الدراسة أسباب و كيفية الاحتياج لتطوير إدارة هذه المشروعات. و تضمنت خلاصة الدراسة أوجه الضعف الإداري بهذه المشروعات و الأسباب المؤدية لذلك و أيضا اشتملت على تحليل كمي للعناصر الرئيسية المؤثرة على إدارة هذه النوعية من المشروعات.

KEYWORDS: Project management, infrastructure, assessment, management enhancement, development, sanitary.

1. INTRODUCTION

The Egyptian Government invested a large amount of capital in the last two decades to improve the capacity of the infrastructure in major cities as well as in other urban and rural regions. Wastewater infrastructure was one of the major areas for these expenditures. The numerous investments being pumped currently in the infrastructure services and that will be pumped in the next years demand a high level of control on the cost of the projects, quality of deliverables, and the time consumed to finish the required tasks. These targets may not be achieved unless the management capacities of all the participants of the infrastructure projects are effectively improved. The study of strengths and weaknesses in the current management knowledge and application of the performing staff is urgently needed as a base for the required improvement fields [1].

The nature of the infrastructure projects is different than that of other construction projects in various faces [2]. The key difference lies in the higher risk potential involved in the infrastructure projects [3]. This is more dramatic in the developing countries where the available data for the existing infrastructure facilities is not sufficient to satisfy the needs for current and future development and expansion of services [4]. Lack of database is parallel to the lack of up-to-date technologies and methodologies in achieving the target progress in infrastructure.

The presented study assesses the current needs in order to enhance the functioning of management knowledge and conduct for the Egyptian infrastructure projects. The analysis was based on investigation performed with senior engineers at the General Organization for Sanitary Drainage. The investigation provides the opinions of the practicing engineers about the major risk potential in the field of the wastewater projects from a managerial point of view. The conclusions of the study stress the drawbacks in the management processes, the reasons for these drawbacks, and the recommendations to enhance the demeanor of project management capacities in this specific area.

2. ASSESSMENT OF MANAGEMENT NEEDS

The management responsibility in infrastructure projects has the traditional definition as the application of resources to achieve the anticipated objectives within specific cost and time limits. Figure (1) shows the management environment with the conventional triangle of management has three heads representing the cost, time, and quality. However, the efforts paid directly to

cost and time management are minor in these projects. The majority of effort is paid to the integration of the different management areas mainly communication, procurement, risk, and change management [5]. It is obvious that quality should be one of the heavy heads in the triangle since the operation and maintainability are prime characteristics of infrastructure. Quality management is an essence to conduct the considered project at the expected level of service through the following tens of years. The level of quality management governs the level of cost for the construction, maintenance, and operation of the facility under contemplation [6].

By definition, the continuous improvement process aims to attain levels of performance that are significantly higher than current levels [7]. The starting point of continuous improvement is the assessment of where we are [1]. The presented study assesses and analyzes the current needs to reach the required target of management knowledge and conduct for the construction projects in the Egyptian infrastructure with focus on sanitary projects.

3. INVESTIGATION PROCESSES

The assessment process was conducted through the senior engineers of the General Organization for Sanitary Drainage. Three modules of investigation were led by the author with the engineers of the organization as a part from a comprehensive program to improve the knowledge and conduct of project management demeanor.

The investigation modules included six sessions per module with each session extending for a full working day. Each module proposed to be attended by ten engineers. However, the actual participants for the three modules were 51 attendees. Each module started with general discussion about the organizational structure and the tasks of each attending engineer in the structure of the organization. This introduction was followed by discussion about special management environment of the infrastructure projects. The risky environment and the need for deterministic system of authorities and responsibilities were elaborated in this phase of discussions.

In the second module, the focus was on the problems that face the application of project management as experienced from the past projects especially within the last five years. The dialogue was directed towards the core of project management knowledge areas and their application in the projects conducted by the organization lately or being conducted at the time of the program. The complications cited by the engineers were grouped and categorized to represent the common difficulties in the infrastructure projects in general.

Based on the output of the second module, the most critical categories were chosen to concentrate upon in the following phase. Sixteen categories were selected by the discussion groups to be evaluated in the third module. The attendees re-discussed the effect of each of the sixteen categories and evaluated their interrelationship to elaborate the impact of the different classes on the added value of the project. The second part of this module allowed the engineers to propose the solutions for the cited problems. By the end of the session, the attendees were asked to rank the sixteen categories according to the impact on the progress of the projects. The author used the outputs to quantify the effect of each category and to build an interdependent quantitative measure for the impact of each parameter.

4. RESULTS OF INVESTIGATION

The following sections present the major outputs from the discussion sessions considered in this paper:

4.1. The Environment of Infrastructure Projects

The combination of environmental, political, and commercial pressures has led the water and wastewater industry to consider alternative and faster methods of application. This has meant projects start earlier, and being completed faster, on or ahead of program [3]. This in turn led to consideration of the overall time to plan, design, and construct a project, in order to establish where economies in the program could be made. The consequences of these considerations led to the examination of target-cost reimbursable contracts as an alternative method of procurement.

4.2. Authority and Responsibility in Public Projects

The majority of construction projects of infrastructure involve organizations. The participants; owner, contractor, subcontractors, and suppliers are not individuals. They are corporations, partnerships, or other forms of business associations. Yet decisions and approvals are required on a daily basis during the performance of a construction contract [8]. It is obvious that each organization must establish lines of authority by designating the individuals who are authorized to make necessary decisions [9]. If this is done in a careful, thoughtful manner, the project will benefit.

Fig. 2 shows authorities and responsibilities as major parameters of the main factors that affect the successfulness of decision-making. The fish-bone diagram integrates the prime reasons to adopt a right decision. These reasons include clear target, authorities, responsibilities, committed management, continuous

development, delegation, communication plan and skills, performance measurements, and data analysis.

4.3. Needs for Improved Construction Project Management

The following are the primary locations where the major management predicaments lie as reported by the practicing engineers:

4.3.1. Contractor

The major problems considered by the engineers are those associated with the contractors. The capacity of the performing contractor is really a principal factor in the management functioning. If the contractor management system is not appropriate he will not be able to match the required level of management targeted by the owner's management. Even if the considered performing contractor is a small firm or a subcontractor he must be able to conform to all the management criteria that set forth by the owner's system and contract terms and conditions.

In many cases, the contractor is not capable of providing a reliable time schedule for the projects. The failure may be referred to the nature of the infrastructure projects that include high-risk potentials that need a high professionalism in expecting the risk sources and assign the logic response to mitigate the impact of these risk events as possible. In some cases, the failure is referred to the lack of experience in infrastructure projects specifically. However, part of the barrier to management in this regard lies on the burden of the engineers who accept the unreliable schedule provided by the contractor from the very beginning. It is obvious that the engineer must not accept any accord that would result in time delay, cost raise, or any type of conflict among the stakeholders of the project.

Another parameter that is adjunct to the quality and to the contract terms is the resident representative of the contractor. Sometimes, in small projects or small tasks assigned to a specific contractor within a large project, the contractor's representative is not qualified to manage the workflow at the required standards or he is supervising several tasks that is difficult to be superintended by a single person at the same time. This happens although the contract terms states that the existence of a qualified representative is a must as long as there is an enduring tasks.

4.3.2. Communication

Gransberg et al. [10] pointed out that public agencies might experience more difficulties in developing longstanding, strategic partnership with private organizations than their counterpart in the private sector. It is because public

agencies would face relatively more constraints on the form and substance of their internal operations and contractual relationships than private organizations do. In this regard, building effective intercommunication is attractive to the public agencies in improving project performance. Also Chan et al. [11] deduced that if interorganizational teamwork is fostered in the project, a successful project outcome would be achieved, project participants would develop a positive view for the project, and their job satisfaction would be higher.

The above-mentioned concept was handled in the investigation from different perspectives. The interrelationship between the general contractor and the subcontractors depends in part on the efficiency of the contractor management tools and techniques. If the contractor is missing the basics of communication necessity and the required tools including qualified staff and technical devices, he will not be able to fulfill the needs of effective project management. Another face of the problem is missed communication between the contractor and the owner or the engineer. This problem arises usually because of missing the communication plan from the early phases of the project. The communication plan between the owner and the contractor must be agreed upon in writing in a separate charter and pointed out in the contract.

Exterior communication constitute an important term of project communication that is the most difficult to plan in advance. The communication with other infrastructure organizations that may be involved is referred to interference between the facilities of these organizations. This dependency is the easiest in the planning phase but when there is a risk symptom for a certain event that is not planned, it is the real problem. Most of these risks arise due to deviation in the data provided or collected by one of the infrastructure organizations. This issue usually needs investigation, correction, redesign, or at least clarification for the deviation. Another sort of exterior communication is that between the performing participants and the communities. The actual problems appear in the rural regions where there is no accurate data for the existing infrastructure neither for the required tasks to be implemented for long time in advance. The awareness of the people in these communities is lower than that required to investigate and improve the facilities at their communities.

4.3.3. Organization

The problems encountered within the organization and similar infrastructure organizations are of prime importance. One of the main problems is the weakness of the information system. The application of the developed technology in information is crawling in its early steps. The available database for the previous projects is not detailed enough to be useful neither in

maintenance and operation phases nor for future extensions and renovations in the provided facilities.

The cycle of collecting, archiving, and retrieving of information need to be integrated in the structure of the organization and the authorities and responsibilities chart. This chart is the key to all management processes needed to provide highly productive projects. The determination of authorities and responsibilities reduces the conflicts among the project's staff and help them to concentrate on the progress and achievements through their specific roles in the project. This determination also helps to create the required esteem for each individual participating in the system by his obvious share.

The performance of the personnel extends to one of the most important tasks that starts in the early phase and continues through the whole project that is preparing and updating contract documents. The compatibility of these documents is a major source of problems to the owner because contractors could utilize any incompatibility in the document like the common inaptness between drawings and specification to ask for time extension or claiming extra cost for the impact on his duties. The qualifications of the performing personnel could be of big trouble to the organization if these qualifications are less than the needed level to the project. These qualifications include technical capacities, communication competence, human interrelationship manipulation, and other management skills. Another important parameter that is related to the qualification of the personnel is the sufficiency and accuracy of design documents. If the design documents are missing some data or encountering some errors the project would be delayed and extra cost would be over loaded to the budget.

5. PRIORITIZATION OF MANAGEMENT NEEDS

Based on the conducted investigation, sixteen major categories were selected as the major items, which need to be stressed in the following phase of improvement. Table (1) presents these sixteen categories sorted alphabetically. The itemization and selection of these categories was made through the discussion groups. Some items were grouped together because of interdependency like communication among the owner, engineer, and contractor internally and externally.

Fig. 4 presents a Pareto diagram showing the normalized weighted values (w_{ni}) of the selected categories. The weighted values were concluded from the individual ranking (R_{ij}) provided by each participant according to the conducted discussions and the furnished grounds. The ranks of each category were sorted

inversely from the least important (1) to the most effective one (16). The inversed ranks were accumulated for all of the participants and sorted finally as per the following relationship;

$$w_{ni} = \frac{\sum_{j=1}^{m} R_{ij}}{mn} \times 100 \qquad \text{Eq. (1)}$$

where (m) denotes the number of participant engineers and (n) denotes the considered categories.

The most effective category that needs to be enhanced as shown in this study is the comprehensiveness of contract terms. The terms and conditions of the contract need to meet all the requirements of the project. The contract must be integrated with the other documentation in the project like drawings, specifications, procurement, and other design and control documents. Also, the ease of the contract language makes it easy for all stakeholders to interpret the contract in the same manner that reduces the conflicts and changes through and after the project execution. The contractor qualification came just behind the contract terms in the sorted raw. If the selection were cost-driven the technical and managerial capacities of the contractor would be of high risk potential for the project from all perspectives including time, cost, and quality.

The need for reliable schedule that meets the requirements of the owner and the capacity of the contractor appears in the third place. Despite that it is rarely that an approved schedule is completed as accepted initially, it is an essence that a meaningful schedule must be prepared and agreed upon in advance to illustrate the full picture in front of the owner and other participants. The fourth position is occupied by the communication with other infrastructure organization. The difficulty of this category arises from being not deliberated in the detailed plan of the infrastructure project but usually considered in the reserve contingency for time and cost of the project.

Organizational policies and distribution of the authorities and responsibilities in a deterministic manner is on of the requests of the senior engineers to improve the managerial performance of the projects. Setting the authorities and responsibilities assists in enhancing the accountability of all the participants in the project and the functional lines too. The sequence of the other categories can be followed at Fig. 4.

6. INTERRELATIONSHIP AMONG MANAGEMENT REQUIREMENTS

The dependency of the main parameters affecting the conduct of management in the civil infrastructure projects in Egypt was discussed and evaluated in the

investigation. Each dual dependency relationship is evaluated and assigned a dependency factor (D_f) on a scale from 1 to 5 with the value of "1" indicating the weakest dependency and the value of "5" indicating the strongest dependency. Table (2) presents the whole concluded matrix for the dependency factors of the sixteen parameters included in the analysis.

The interdependency factors of each parameter are accumulated generating another factor that resembles the over all interrelationship of this parameter with respect to the whole management environment process. This interdependency factor (D_{if}) can be represented mathematically in the following form;

$$D_{if} = \sum_{i}^{n} D_f \qquad \text{Eq. (2)}$$

where n is the total number of the considered parameters.

The normalized weighted value (w_{ni}) is introduced to calculate the weight of each category (w_i) by the simple form of;

$$w_i = \frac{w_{ni}}{\sum_{i=1}^{n} w_{ni}} \qquad \text{Eq. (3)}$$

The multiplication product of each category's interdependency factor and its weight was called the interdependency weight (I_{wi}) and calculated as shown in the following equation;

$$I_{wi} = D_{if} \times w_i \qquad \text{Eq. (4)}$$

The resultant factor is necessary to evaluate the importance of the category with respect to its incorporation with other categories. The values of the weights (w_i) and interdependency weights (I_{wi}) are given in Table (2).

The results show that commitment to contract and communications are the most interactive categories that affect and being affected by other categories in the infrastructure project management process. On the other hand, the weights of the categories play the dominant role in controlling the value of the interdependency weights. Hence, the highest interdependency weights were obtained for the requirement of a reliable and controllable schedule and for the comprehensiveness of the contract terms. Note that the late categories had the highest weight values.

The categories were divided into three levels, which are project, organization, and macro levels. The project level includes the categories that contribute directly to the project and controlled by the stakeholders of the project. The

organization level includes the categories that influence that project as well as other projects and the performing organization within the scope of civil infrastructure projects. The macro levels accounts for the categories that associate in the policy and economy of the country and the affecting region. The distribution of the considered categories over the three levels is shown in Table (3). Table (3) introduces the coefficient of correlation matrix for the considered sixteen categories while Table (4) introduces the coefficient of correlation matrix based on integrated levels.

7. CONCLUSIONS

Good fairies do not create improved management. There are no quick fixes, workshops, or one-shot organization development interventions that can automatically construct a lasting, productive project management system. To do so, it requires commitment at all levels of the organization over an extended length of time. Good fairies will fail to produce results after the initial enthusiasm for them diminishes unless they become institutionalized in the culture of the organization. It is impossible to overemphasize the value of perceived individual responsibility for the common good of the group. Individual responsibility in a collectivity provides a strong basis of accountability.

The bottom line to improved project management is that the stakeholders require controlling what is vigorous and productive. This means placing people where they can build on their strengths and do what they do best. It means keeping the lines of communication open, being flexible, and achieving a reasonable balance between the needs of the organization and the needs of community.

Quantitative analyses are urgently recommended to evaluate the performance of each trade in the infrastructure field to determine the sources of strength and weakness of the trade. Also, determining the dependency of the governing parameters and their interrelationship is important to conclude the prioritized ranking of the categories to be considered.

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Table 1. Focal needs of construction management in infrastructure projects

No.	Category
1	Authorities & responsibilities
2	Commitment to contract
3	Commitment to schedule
4	Communication
5	Contract terms
6	Contractor representative
7	Contractor selection
8	Control agencies
9	Delay penalties
10	Document cycle
11	Documents compatibility
12	Neglecting schedule
13	Other infrastructure organizations
14	Permits & processes
15	Quality control
16	Technical qualification

Table (2): Dual dependency coefficients and the interdependency factors

	Contract terms	Reliable schedule	Commitment to contract	Commitment to schedule	Document compatibility	Quality Control	Contractor representative	Delay penalties	Contractor selection	Authorities & responsibilities	Document cycle	Communication	Control agencies	Technical qualification	Other infrastructure organization	Permits & processes
Contract terms		2	5	4	4	3	1	5	1	2	2	2	2	2	1	1
Reliable schedule	2		5	5	3	1	1	1	1	2	2	3	3	3	3	3
Commitment to contract	5	5		5	4	3	3	5	1	2	3	3	3	3	1	3
Commitment to schedule	4	5	5		2	1	1	1	1	2	2	3	3	3	3	3
Document compatibility	4	3	4	2		2	2	3	1	2	4	4	3	2	1	1
Quality Control	3	1	3	1	2		3	1	1	3	3	3	3	4	1	1
Contractor representative	1	1	2	1	2	3		1	1	2	1	3	3	3	1	1
Delay penalties	5	1	5	1	3	1	1		2	3	2	3	3	3	2	2
Contractor selection	1	1	1	1	1	1	1	2		3	1	1	3	1	1	1
Authorities & responsibilities	2	2	2	2	2	3	2	3	3		3	3	3	3	1	1
Document cycle	2	2	3	2	4	3	1	2	1	3		5	4	3	1	3
Communication	2	3	3	3	4	3	3	3	1	3	5		3	4	3	3
Control agencies	2	3	3	3	3	3	3	3	3	3	4	3		4	1	1
Technical qualification	2	3	3	3	2	4	3	3	1	3	3	4	4		1	1
Other infrastructure organization	1	3	1	3	1	1	1	2	1	1	1	3	1	1		4
Permits & processes	1	3	3	3	1	1	1	2	1	1	3	3	1	1	4	
Interdependency factor (D_{if})	37	38	48	39	38	33	27	37	20	35	39	46	42	40	25	29
Weight (w_i)	0.113	0.110	0.083	0.077	0.072	0.072	0.066	0.063	0.062	0.062	0.053	0.053	0.043	0.030	0.021	0.021
Interdependency weight (I_{wi})	4.17	4.19	3.97	3.00	2.75	2.39	1.77	2.34	1.24	2.17	2.06	2.43	1.79	1.20	0.52	0.60

Table (3): Coefficients of correlation among different factors

	Level	Contract terms	Reliable schedule	Commitment to contract	Commitment to schedule	Document compatibility	Quality Control	Contractor representative	Delay penalties	Contractor selection	Authorities & responsibilities	Document cycle	Communication	Control agencies	Technical qualification	Other infrastructure organization	Permits & processes
Contract terms	Project		0.36	0.80	0.26	0.42	(0.25)	(0.14)	(0.13)	(0.23)	(0.16)	(0.18)	0.03	0.32	0.21	0.06	0.16
Reliable schedule		0.36		0.42	0.90	0.28	0.02	0.15	0.22	(0.13)	(0.28)	0.10	0.09	(0.03)	0.03	0.35	0.63
Commitment to contract		0.80	0.42		0.51	0.67	0.02	(0.08)	0.22	(0.36)	(0.22)	0.01	(0.01)	0.16	0.20	0.10	0.25
Commitment to schedule		0.26	0.90	0.51		0.43	0.16	0.10	0.48	(0.15)	(0.29)	0.07	(0.04)	(0.13)	(0.05)	0.20	0.46
Document compatibility		0.42	0.28	0.67	0.43		0.49	0.24	0.45	(0.15)	0.29	0.33	0.11	0.41	0.34	(0.32)	0.03
Quality Control		(0.25)	0.02	0.02	0.16	0.49		0.74	0.59	0.18	0.64	0.46	0.06	0.51	0.38	(0.50)	(0.29)
Contractor representative		(0.14)	0.15	(0.08)	0.10	0.24	0.74		0.37	0.21	0.52	0.63	0.36	0.56	0.51	(0.29)	0.06
Delay penalties		(0.13)	0.22	0.22	0.48	0.45	0.59	0.37		0.13	0.05	0.27	(0.09)	0.03	(0.14)	(0.35)	(0.03)
Contractor selection		(0.23)	(0.13)	(0.36)	(0.15)	(0.15)	0.18	0.21	0.13		0.45	(0.08)	(0.48)	0.11	(0.03)	0.16	0.03
Authorities & responsibilities	Industry	(0.16)	(0.28)	(0.22)	(0.29)	0.29	0.64	0.52	0.05	0.45		0.33	0.07	0.80	0.63	(0.31)	(0.24)
Document cycle		(0.18)	0.10	0.01	0.07	0.33	0.46	0.63	0.27	(0.08)	0.33		0.71	0.41	0.40	0.06	0.36
Communication		0.03	0.09	(0.01)	(0.04)	0.11	0.06	0.36	(0.09)	(0.48)	0.07	0.71		0.39	0.41	(0.05)	0.23
Control agencies		0.32	(0.03)	0.16	(0.13)	0.41	0.51	0.56	0.03	0.11	0.80	0.41	0.39		0.71	(0.32)	(0.09)
Technical qualification		0.21	0.03	0.20	(0.05)	0.34	0.38	0.51	(0.14)	(0.03)	0.63	0.40	0.41	0.71		(0.04)	0.04
Other infrastructure organization	Macro	0.06	0.35	0.10	0.20	(0.32)	(0.50)	(0.29)	(0.35)	0.16	(0.31)	0.06	(0.05)	(0.32)	(0.04)		0.79
Permits & processes		0.16	0.63	0.25	0.46	0.03	(0.29)	0.06	(0.03)	0.03	(0.24)	0.36	0.23	(0.09)	0.04	0.79	

Table (4): Dependency factor among different levels

	Project	Organization	Macro
Project	0.55	0.48	0.35
Organization	0.48	0.59	0.30
Macro	0.35	0.30	0.80

Fig. 1. Project management environment

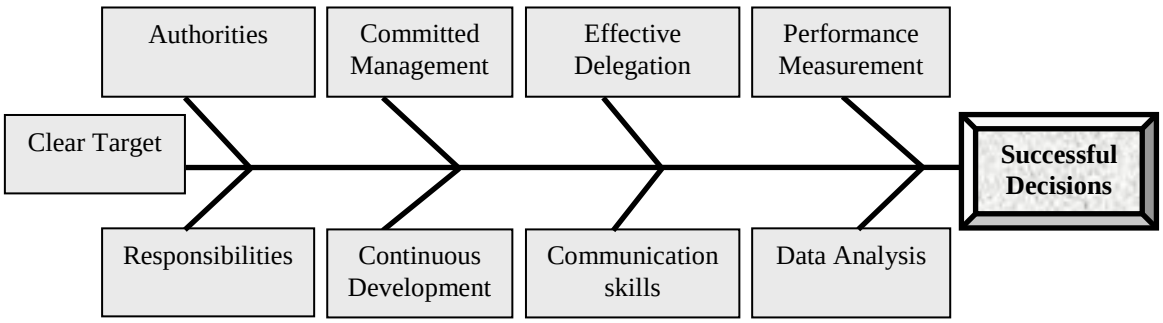

Fig. 2. Main parameters affecting decision making in organizations

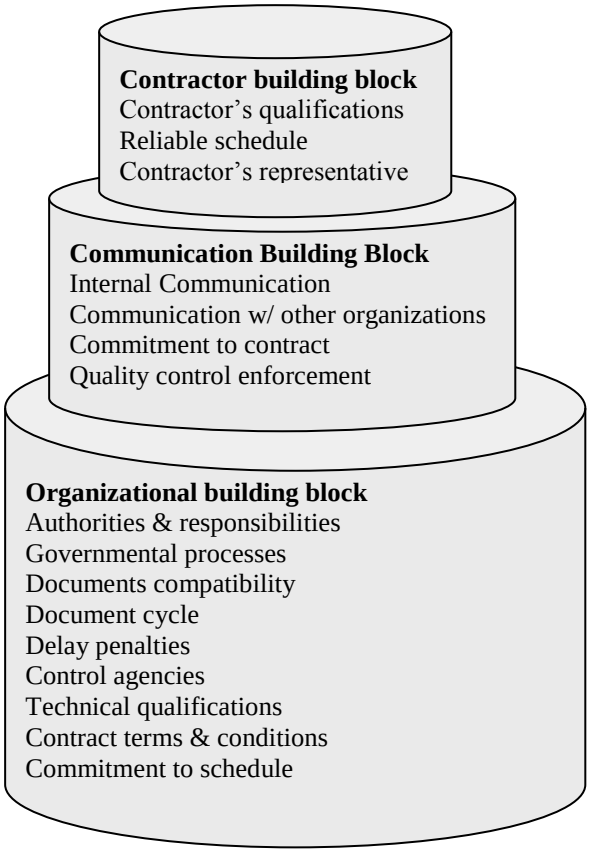

Fig. 3. Management needs in infrastructure projects

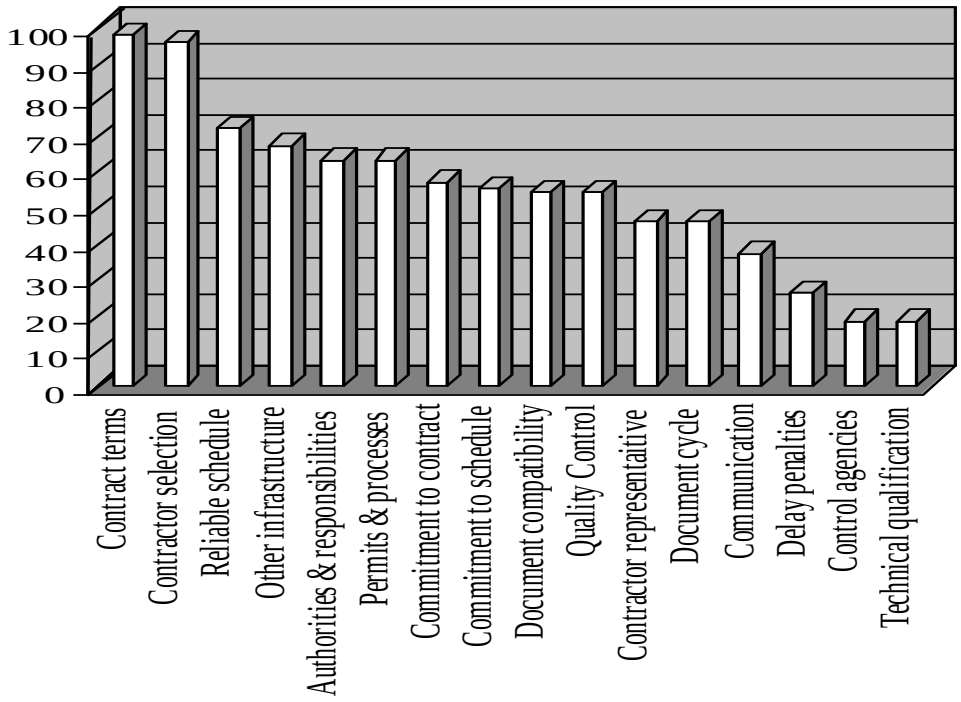

Fig. 4. Pareto diagram for the normalized weighted values of the effective categories in infrastructure project management