

Concept to Enhance the Project Success and Promote the Implementation of Success Factors in Infrastructure Projects

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Abstract—Infrastructure projects are often subjected to delays and cost overruns and mistakenly described as unsuccessful projects. These projects have many peculiarities such as public attention, impact on the environment, subjected to special regulations, etc. They also deal with several stakeholders with different motivations and face unique risks. With this in mind we need to reconsider our approach to manage them, define their success factors and implement these success factors. Infrastructure projects are not only lacking a unified meaning of project success or a definition of success factors, but also a clear method to implement these factors. This paper investigates this gap and introduces a concept to implement success factors in an efficient way, taking into consideration the specific characteristics of infrastructure projects. This concept consists of six enablers such as project organization, project team, project management workflow, contract management, communication and knowledge transfer and project documentations. These enablers allow other success factors to be efficiently implemented in projects. In conclusion, this paper provides project managers as well as company managers with a tool to define and implement success factors efficiently in their projects, along with upgrading their assets for the coming projects. This tool consists of processes and validated checklists to ensure the best use of company resources and knowledge. Due to the special features of infrastructure projects this tool will be tested in the German infrastructure market. However, it is meant to be adaptable to other markets and industries.

Keywords—Infrastructure projects, enablers, project success, success factors, transportation projects.

I. INTRODUCTION TO CHALLENGES IN INFRASTRUCTURE PROJECTS

COST overruns and delays during the execution of infrastructure projects are a worldwide phenomenon. Almost 9 projects of each 10 infrastructure projects were subjected to delays and/or cost overruns at their completion [1]. Moreover, public acceptance towards this type of projects in some countries e.g. Germany has become a slatted case [2]. The reasons of these problems can lay very deep in the project planning or even further in the construction industry itself. These reasons are extracted from the literature and presented as followed:

1. The goals and objectives of infrastructure projects can be strongly influenced by the politics, which tend to be very optimistic toward risks and cost estimations.
2. The business environment of construction projects is always characterized as having adversarial relationships,

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fragmented operation processes, a lack of genuine cooperation over time, and complexity [3]. Moreover, conflicts are presented in almost all construction projects [4]

3. These projects are usually one of kind projects [5, p.7] and the project owner might not have enough experience to plan, procure, execute and operate them [6], [7, p.7]. Further the complexity of these projects challenges our project management approaches. Therefore innovative project management approaches need to be developed especially for them [8].
4. Infrastructure projects are meant to cover a very wide scope, which in most cases cannot be clearly defined. That causes many changes during project life cycle, which result in higher project costs, project delays, duplicating work and lower productivity [9]. This huge number of changes can even endanger the project functionality and lead to function failure [10].
5. The construction business witnesses tough competition due to a large number of competitors in the industry [11] and this business is considered as one of the riskiest businesses in the world [12].
6. As public projects, owners are obligated to certain laws and regulations, which lead in the practice to award the project to the contractor with the cheapest price [7, p.8]. Furthermore the common contracts used in construction industry especially by governmental projects impede the collaboration between project stakeholders [13] and usually described as confrontational contracts [14]
7. Patanakul et al. summarized the causes for the governmental large-scale poor performance as: complexity with regard to scope and number of stakeholders, financial difficulties and organizational deficiencies, frequent change orders, poor risk management, productivity problems, poor project governance and management [15].
8. Long et al. consider social and technical issue as reasons for poor governmental project performance [16].
9. The public owners might not invest enough time and money in the project planning. Furthermore, some governmental projects may be tendered without sufficient planning [7, p.7]. This poor planning can lead to further delays and cost overruns [17].
10. Ehgartner and Fischer considered owners' late decisions at the construction site – because of bureaucracy issues, lack of skills or authorities - to be the main reason for

further problems e.g. conflicts, delays or cost overruns [18].

11. Lack of transparency towards the public, which has the right to receive reliable information on costs, risks and deadlines, can lead to public demonstration against projects and endanger the whole project [7, p.15].
12. Planning of infrastructure projects is a long process and a wide range of stakeholders must be considered.

II. PROJECT SUCCESS

Despite the wide range of project success definitions, project success is mainly associated with achieving project goals [19], gaining satisfaction of project stakeholders by delivering their expectations [20], adding value to the organization [21] and the society [22]. Measuring the performance of any construction project in terms of success or failure though looks simple, is in fact a very complex process [23] and measuring the success of infrastructure project is even more complicated [22].

Linear projects such as roads or railways usually have a long design duration (up to 25 years [24]), significant impact on the nature and the life of people and a very wide scope of work [5, p.7]. Further as governmental projects are financed by taxes, they attract lots of public attention and get influenced by politics [5, p.7]. These conditions lead to a vast number of project stakeholders, who can affect or get affected by the project.

Since project stakeholders might have different expectations and motivations, their definition of project success could also differ. This implies that, a project can seem to be successful to the owner or the client, yet not successful to the contractor and vice versa [25] or a project might be seen as successful only by its internal stakeholders. In other words project success means different things to different people. References [26]-[28] claim that, their no need to assign a unified definition of project success.

Since the main concern of project management is to deliver successful project, the question of how project success can be evaluated has attracted so many scholars in last five decades at least e.g. [5], [26], [34] und [93]. Different models have been developed to assess the project success in general or for a certain type of projects such as IT-projects or construction projects.

1. Micro and macro project success [29]
2. Project success and project management success [30]
3. Logical Framework Method (differences between product success and project management success) [31]
4. Multidimensional strategic concept (project efficiency, impact on customer, business success, prepare for the future) [32]
5. IPMA Project Excellence (Organization, Results) [33]
6. Five levels for IT-project success (process success, project success, deliverable success, business success, strategic success) [34]
7. Project Evaluation Holistic Framework (relevance, efficiency, effectiveness and sustainability) [35]
8. Assessment Tool for Infrastructure Projects (IPAT)

(Political context, objectives and business case, functional specifications, finances, risks, legal procedures, technology, knowledge, organization and management, interfaces, stakeholders, contracting) [36, pp.92-101]

9. Six-Dimensional project success (Function, Management, ownership, organization, business and strategic success) [22]

The above-mentioned models tend to evaluate the project success at different phases of the project life cycle and according to different stakeholders' prospective. Yet only the IPAT, the holistic success framework model and the six-dimensional success model were developed to handle infrastructure projects. All these models introduce different success factors or recommendations to enhance the success chances of projects.

III. CRITICAL SUCCESS FACTORS

The term success factor (SF) was first coined by Rockart [37] and since then, it has become one of the most researched topics in the field of project management. The first definition of SF was emphasized by Rockart as "the limited number of areas in which results, if satisfactory, will ensure successful competitive performance for the organization" [37]. Later on he modified this definition and stated critical success factors (CSF) as "those few key factors absolutely necessary for reach goals" [38].

Depending on the literature the following definitions of success factors resp. critical success were selected to reflect the functions and usefulness of them:

1. CSF are those few things that must go well to ensure the success of a manager and an organization [39];
2. CSF are a set of factors that, when thoroughly and completely satisfied, ensure the successful completion of a facility and predict the success of a project [40];
3. CSF are those fundamental issues inherent in the project, which must be maintained in order for team working to take place in an efficient and effective manner and they require day-to-day attention and operate throughout the life of the project [41, p.270]
4. CSF are situations in which special attention is needed from management because of the importance that they bring to the organization [42]
5. Luu et al. define CSFs as limited number of areas in which satisfactory results will ensure successful competitive performance for the organization [43] and consequently they are essential for any business to flourish [44].
6. CSF denotes a certain element which significantly contributes to and is crucially vital for the success of a project [45].
7. They are the core aspects where "things must go right for the business to flourish [44]

Identifying project SF and the different perceptions of these factors by stakeholders has been extensively studied in the Project Management literature yet remains a matter of debate [46].

A. Importance of CSF

Won et al. asserted CSF to be crucial for any type of management or technology implementation and they can serve projects and organizations very well [47].

CSF help project managers to achieve predetermined goals [48], focus on the control of key factors and allow them to make reasonable resource allocations [49], [50], better control the project objectives and overall success [50], identify good projects worth pursuing and problems on current projects for corrective actions [40] and select the project team members [51].

Many scholars postulated that CSF are very helpful not only for projects, but also for organizations [52]-[54]. The early researches done in this field acknowledged the relationship between CSF and organization performance e. g. Boynton and Zmud mentioned, that CSF include issues vital to an organization's current operating activities and its future success [39]. A more organizational-oriented definition was written by McCabe "CSF as statements indicating how improved business practice must be achieved if an organization is to be able to accomplish its mission." [55]. Further, CSF can support firms decide their strategic planning [45]. Phua claimed that firms with good knowledge on how to identify and implement CSF are more productive, effective and most likely to have competitive advantages over their competitors [56].

B. Problems with CSF

In spite of the efforts invested to define SF in the last decades, the question which of these success factors are the critical ones (CSF) is a matter of debate. Sanvido et al. claimed that not all factors would have the same influence on the project outputs and those, which affect project performance the most are CSF [40]. Benchtell stated "vital and few" as two main key words for defining CSF [57, p.20f]. A study done by Park shows that stakeholders judge and evaluate SF very differently [58]. Moreover, what could be a SF for the contractor, e.g. having a claim management team at site, would not be a SF for the owner and could even endanger the owner-contractor relationship.

Despite some SF will fit to all projects, clear project goals or top management support, it is not useful or even possible to develop a SF-list that will fit to all projects [45]. Even if some SF, e.g. top management support, will fit to almost every project, the implementation of them will differ from a project to another.

The effects of implementing one or more SF in a project are considered as controversial subject in both the theoretical and practical fields. Projects, resp. construction projects, include complicated scope of work and get affected with a wide range of variables, which makes it very difficult to separate one factor and calculate its effect on the project success and even more difficult to quantify this effect (e.g. Partnering [59]). Kuprenas criticized that specific research to quantify the impacts of SF are not sufficient [60]. Moreover, having SF well implemented does not guarantee project success; in fact SF can only increase the success chances and lead projects to

the right track.

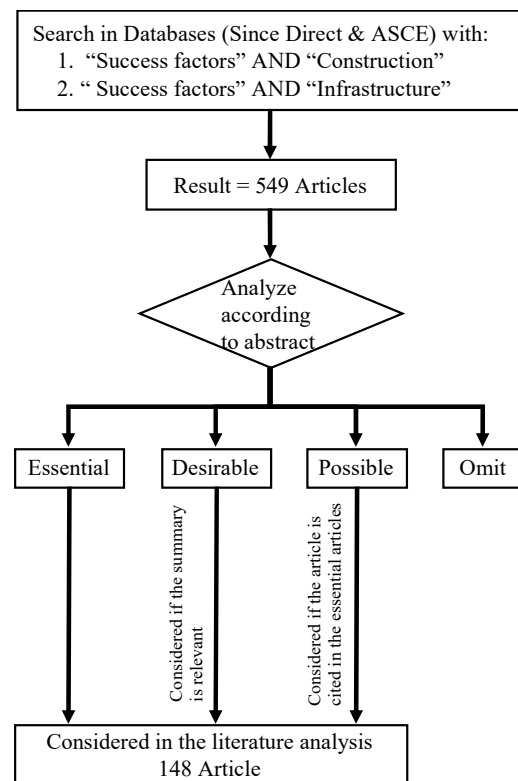
IV. RESEARCH METHODOLOGY

A. Literature Analyses

This research started with an intensive structured literature analyses, which according to Jesson et al. can provide a systematic, transparent means for gathering, synthesizing and appraising the findings of studies on a particular topic or question [61, p.104].

Within the scope of this literature analysis, two main databases (Science Direct and American Society of Civil Engineering) were searched to emphasize the statuesque of SF-research in construction projects and infrastructure projects.

Each of the databases has been surveyed using these two combinations of keywords (Success factors & Construction) and (Success Factors & Infrastructure) that generate 548 articles out of four trails. The duplicated articles were eliminated and then all the remained articles were analyzed according to abstract. Accordingly these articles were sorted in four categories: a) essential articles, which are very relevant to this research scope; b) desirable, which were reanalyzed according to their summary and respectively as essential or omit classified; c) possible, which could be only considered if there were frequently cited in the essential articles; d) omitted, which have no relevance to the research scope, Fig. 1.



ASCE: American Society of Civil Engineering

Fig. 1 Structure of the literature analysis

As a result of these procedures, 148 articles were fully analyzed during this research. This analysis provided a reliable overall view on how SF have been defined and implemented in projects. These articles can be sorted into four categories as shown in Table I.

1. Articles tend to search for new SF for projects in general or for certain aspects e.g. safety, stakeholder management, value engineering, project partnering, etc.
2. Articles tend to periodize SF based on questionnaire or interviews and define CSF.
3. Articles tend to analyze project -case studies- and document lessons learned and best practices as SF resp. CSF
4. Articles tried to study the relationship between SC and SF.

TABLE I
TRENDS IN THE RESEARCHED ARTICLES

Category 1	[12], [13], [40], [48], [51], [52], [59], [62]-[75]	21
Category 2	[47], [48], [53], [58], [76]-[85]	14
Category 3	[86]-[90]	5
Category 4	[49], [91]-[93]	4

B. Research Gap

Results from the literature analysis show that the implementation of SF is not well studied in the literature. As the matter of fact, many scholars (21 articles) tend to define new SF (Category 1) or prioritize SF and define CSF (Category 2).

Chan et al. defined success criteria (SC) as “inter-goals, by which the overall project success can be judged” [48]. Linking SC to SF (Category 4) has not been given the due attention, which makes it very ambiguous to say which SF is more likely to help a project to achieve which success criteria. According to Hwang and Lim, there is not a universal definition for CSFs or their measurements [82].

In order to bridge this gap, this research develops a concept to clarify and ease the IP of SF in projects especially infrastructure projects.

V. IMPLEMENTATION MODEL FOR SF IN INFRASTRUCTURE PROJECTS

Depending on the literature as well as expert interviews, this research develops a concept to support project managers through the implementation of SF in their projects. The implementation of SF results in changes into some areas or requires more attention at some others. This concept defines five implementation drivers to help project managers to anticipate changes resulting from the implementation of SF. It also leads project manager to identify the most important aspects to focus on and give them more care. These implementation drivers are organization-team, project management workflow, contract management, communication and knowledge transfer and execution documentations (Fig. 2).

As shown in Fig. 2, the implementation drivers are represented with the slides; the holes stand for certain aspects resp. questions to be asked within this implementation driver

and they are opened only if the question is well answered; each line represents a SF. This concept acknowledges the fact that SF vary among project stakeholders. It, therefore, differentiates between owners' SF and contractors' SF. In the following point these implementation drivers will be explained.

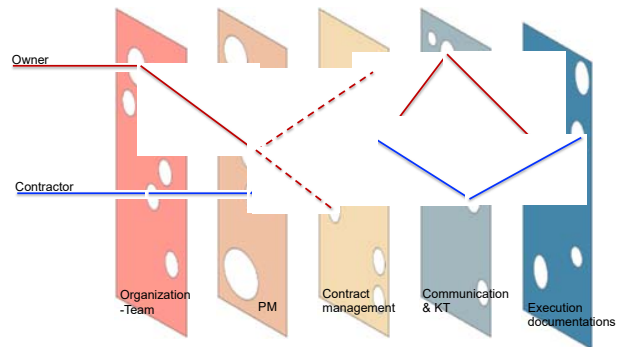


Fig. 2 SF implementation concept

1. Organization-Team

In order to successfully implement a SF, the organization as well as the project team need to accept it and be able to recognize their benefits; then to prepare themselves to the implementation process; and finally to act according to the implementation plan.

Before starting with the implementation of any SF both organization and team must be able to realize and identify their benefits out of it. The expert interviews concluded that the organization and team motivations towards the implementation of a certain SF could be aligned in one way or another.

Organizations are more presumably to implement a certain SF, if it can maximize their profit, improve their reputation and professional image or give them competitive advantages over their competitors. Employee resp. project teams are motivated to implement a certain SF, if it can ease their day-to-day work, contribute to their carrier and further education, give them higher positions in their companies or bring them bigger salaries and bonuses. Both these sides can be brought together with good human capital management and social capital management, in which an organization considers its employees as its most valuable capital and integrate their individual targets as a part of the organizational planning.

After realizing realizing the benefits of a SF, the organization and the team need to be prepared to implement it. Tasks need to be allocated at both sides, the organization needs to assign the required resources, prepare the infrastructure (i.e. purchase software or devices), prepare the required learning or coaching to enable employees to implement SF efficiently. Employees at the other side need to overcome their resistance to change, engage and motivate themselves towards the new changes. At this point, organizations need to carefully monitor their social capital; employees have now acquired new skills and may be approached with better offers from bigger companies or try to

seek better job opportunities according to their new skills. A good social capital (e.g. working atmosphere, good relationship to colleges and managers) can keep them more loyal and engaged with their current organization.

The organization, represented by its top management, needs to support the implementation process of SF in order to remain the momentum and keep the changes going. Zhao et al. assert that the missing top management support is one of the main reasons for failure implementation of enterprise risk management (ERM), however the benefits of ERM to the organization and the project were well recognized [89].

2. Project Management Workflow

The second implementation driver is project management resp. project management workflow. Project management is defined as “the application of knowledge, skills, tools and techniques to project activates to meet the project requirements and it accomplished through the appreciate application and integration of the project management processes identified for the project” [94, p.5]. Project management has been well recognized as a crucial competency for achieving successful projects [95] and organizational strategies [96].

Project management guidelines such as PMBOK, ISO, PRINCE2 and DIN-Norm tried to set up a standard process to plan and execute projects. These processes lead later on to developing a project schedule management plan defined by PMI as “...plan, that establishes the criteria and the activities for developing, monitoring, and controlling the project’s schedule” [94, p.148]. These processes and activities are assigned to costs and risks and any changes to the project workflow must be integrated into the project management plan.

Due to the uniqueness of projects, each project has its one-of-a-kind sequence of processes resp. workflow. The implementation of SF in projects can affect these processes. Fig. 3 shows exemplary integration of SF into a PMBOK sample project schedule.

Fig. 3 shows an example of the potential impacts on the project workflow. Each project has some SF and these SF are associated with implementation procedure (IP). These IP are new actions or activities, which enable project team to efficiently implement a SF. Accordingly, project managers need to define the wright SF for their project and then find out how these SF are going to be implemented by defining IP to each SF. These IP could change the project workflow by adding or editing some processes. Questions to be asked here are for example: With which IP can a SF be carried out? How can the IPs be integrated into the project workflow? Which processes are going to interfere with the implementation? How could that affect the project management plan? Is there is any need to adopt some processes or to develop some new processes? How can the implementation of these SF be monitored?

3. Contract Management

The third implementation driver in this model is contract

management. Contracts form the basis for all business processes and relationships with potential partners [97, p.3]. Project delivery and project contracts define the roles and responsibilities of the parties involved in a project and establish the project execution framework [72]. Harper and Waldrop conducted that due to the complexity and uniqueness of construction projects, there is no one-fits-all contract or delivery method in this industry [13].

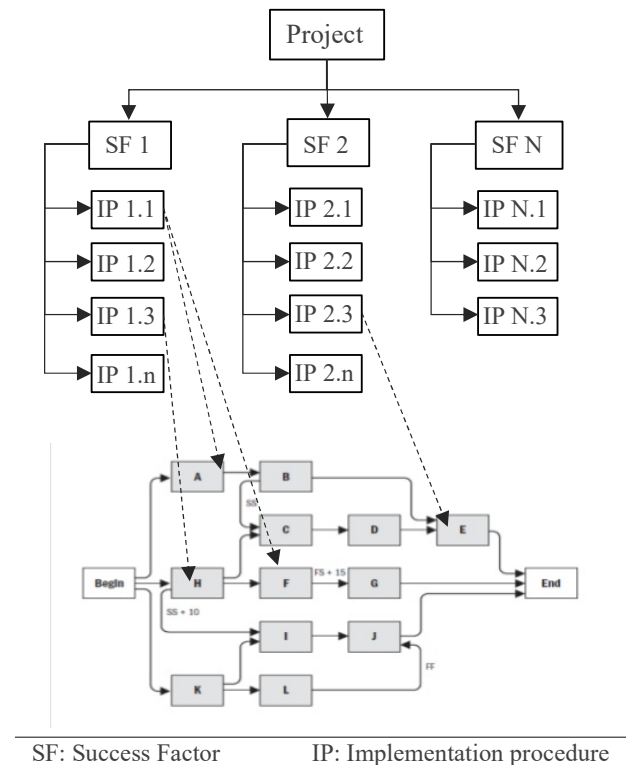


Fig. 3 Effects of SF on the project schedule plan (based on [94, p.160])

Contract management describes all planning and organizational activities that are connected with the design and realization of the contract [98, p.984]; Carter et al. define it as “the creation, execution and analysis of the contract” [99]. It has been recognized as an essential factor for successful projects as well as successful project management [100]. Moreover, contract management can provide project stakeholders with a reasonable forecast of project success [101, p.174] and it provides a link between ERM and project risks [102, p.15]. However, many scholars have studied the effect of contracts on the project outputs resp. project success [40], [49], [72], [103]-[107], the effects of contracts on the implementation of SF have not been given the required attention in the literature.

As governmental projects, infrastructure projects need to follow certain laws and contract models. The contract type does not only affect the project outputs, but also affect the ability to implement certain SF or not e.g. alternative dispute resolution (ADR), using of recycled materials, acceptance of

value engineering proposals, etc. Moreover, the Implementation of SF generates new responsibilities or even new risks that should be integrated somehow in the contract. Further, some SF might require special contracts to enable the involvement of subcontractors or consultants. In this implementation driver, project stakeholders need to make it clear if they can implement a certain SF within the current contract or not. Consequently, they need to review the contract and identify all clauses that can interfere with the implementation of this SF. Finally, they might need to develop new clauses for example to 1) identify and allocate new risks and responsibilities; 2) arrange the work done by third parties e.g. subcontractors; 3) regulate change management procedures; 4) regulations to control costs and duration; 5) regulations for approval and commissioning [7, p.41], [108, p.15].

4. Communication and Knowledge Transfer

Bender and Fish define knowledge as “information interpreted by the individual and applied to the purpose for which it is needed” [109] and Grant considers it to be the most important strategic resource of organizations [110].

Knowledge transfer refers to “a process through which one unit (e.g., group, department, or division) is affected by the experiences of another” [111] and it requires both knowledge seeking and knowledge sharing [112].

Communication is “a two-way process between the sender(s) and receiver(s) through commonly used media” [113]. Scholars claim that successful projects require an open communication, in which project-participants can freely speak about their opinions, fears and thoughts [13], [59], [77].

Construction project success in general is directly related to continuous access to accurate project information [114].

The implementation of SF can affect the communication between project stakeholders. They may need to adopt their existing communication channels or even develop new ones. In this regard many questions need to be answered organization-internally and organization-externally e. g. which knowledge is required for the implementation of SF? How to get this knowledge? How to communicate this knowledge inside the organization? Which decisions need to be taken according to which information? Which information does the partner need to provide? How to prove this information? How to contribute to this information? In which format will information be communicated and documented? Which deadlines will be set to take decisions according to the provided information?

5. Project Documentations

The fifth and the last implementation driver in this concept is project documentation. Project documentation includes drawing, bills of quantities, and specification. They are considered as key elements to pass information between the project parties as well as to the construction site [71].

Even with building information modelling (BIM) the construction site will still depend on 2D drawings during the execution phase. The description of particular activity or

particular spot at the construction site goes through many different drawing and different engineers. Any change to any of these drawings must be reviewed in all other drawings and plans.

The implementation of some SF can cause changes to the execution plans or to the site layout plan e.g. using of recycled material that needs certain preparation on the site logistics. Value engineering proposals can cause also changes to the planning that need to be carefully considered to insure no conflicts during the work. All these changes need to be documented during the project life cycle. This implementation driver enables the project manager to ensure that all changes resulting from the SFs are integrated into all drawing and the information at the construction site is all updated. Further it helps to generate, and document lessons learned and best practice.

VI. HOW TO USE THIS MODEL

In order to get the best use of this model, the following steps are recommended:

1. Both parties (Owner and Contractor) shall individually define SF for their own and for the project. These SF are to be clarified in detail using the implementation concept. They can use their experience from the old projects and develop a list of SF.
2. This concept will help each party to find out the intersections with the other party during the implementation phase. These intersections are to be clarified, discussed and given more consideration in the implementation phase.
3. Project partners need to hold a workshop to inform each other about their SF. Both parties will together use this model to clarify and plan the implementation of the project-SF. That can provide project partners with many advantages such as:
 - a. Collaborative selection of project-SF
 - b. Clear view of the implementation phase
 - c. Early identification of intersections during the execution phase
 - d. Joint controlling procedures and milestones

VII. SUMMARY

Though, project management literature includes many SF, it lacks a clear methodology to put them into practice. This is a reason of many why projects do not reach the expectation of their stakeholder. In order to bridge this gap, an implementation model has been developed to guide project managers implementing their SF. This model consists of five enablers, each include specific questions and/or aspects or advice to lead the project managers through the implementation process.

VIII. LIMITATIONS AND RECOMMENDATIONS

This model was developed biased on the idea that the implementation of SF generates changes to certain managerial aspects by projects and organizations. This model tends to

anticipate these changes in construction industry and accordingly provides the project manager with solutions or a guidance how the solutions might look like.

Only literature regarding the construction industry had been reviewed and experts from the construction industry have been interviewed. For these reasons we recommend further and wider testing of this concept in other industries.

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