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Project configuration by means of network theory

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Abstract

In this paper, we propose a novel approach to determine an appropriate sequence to develop the components of a project management plan. Some newcomers to project management become overwhelmed due to the complex relations within these components. Network theory is a widely used tool in fields with complex relations within entities, but it has not yet been applied to configure a project management plan. Although our approach is compatible with any project management standard, the Project Management Body of Knowledge (PMBOK) is an excellent example to illustrate how to apply this methodology due to the complex interdependence among its processes.

Keywords: Project management; Configuration management; PMBOK guide; Project management plan; Network theory

1. Introduction

In recent years, due to enterprise's environmental changes, many companies have orientated their activity to the execution of projects (PricewaterhouseCoopers, 2012). In this context, several authors have studied the relation between the project management discipline and project management success. For example, Dvir et al. (2003) suggest that even tough project success is not statistically influenced by the level of development of project management processes and procedures, it has a positively correlation with the definition of the project requirements and technical specifications. More recently, Fortune and White (2006) performed a wide literature review over 63 publications on project critical success factors, highlighting—among other factors—the importance of a strong/detailed plan kept up to date. Other recent studies also highlight the impact of project management on project success based on empirical data from project management professionals (Berssaneti and Carvalho, 2013; Golini et al., 2015; Joslin and Müller, 2015; Mir and Pinnington, 2014; Todorović et al., 2015). These studies evidence the importance of project management as a part of project success and thus justify the creation of a well-organized project management plan that ensures that this plan is distributed to all members of the project team and stakeholders of the project (Lester, 2014). Notice, however, that the project plan is only a part of project success. There are many other critical success factors related to goals well defined (Turner and Cochrane, 1993) and organization well defined (Basu, 2014).

Due to the wide diffusion of the Project Management Institute's (PMI) standard "Project Management Body of Knowledge, PMBOK" (PMI, 2013) as a guide to create a project management plan, many authors have analyzed the relative importance of the PMBOK knowledge areas in project success. For example, Belout and Gauvreau (2004) analyze the impact of human resource management on project success, concluding that personnel factor is only a managerial variable, which is in concordance with the analysis provided by Pinto and Prescott (1988). Raymond and Bergeron (2008) highlight the importance of a project management information system based on an empirical study through 224 project managers and project management consultants; Davis (2014) studies the perception of project success by different stakeholders. In the same line, the empirical study among 783 project managers carried out by Zwikael (2009) concludes that time, risk, scope and human

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resources are the PMBOK knowledge areas that most influence project success. Therefore, there is not a general agreement on what knowledge areas are the most critical. In fact, as the PMBOK states, it is the responsibility of the project team to decide to what extent to develop each knowledge area in every particular project.

Creating a project management plan is one of the first challenges for a project manager. It is not an easy task due to the complex interdependence among its comprising documents: the elaboration of a project document requires bearing in mind the information contained in other project documents and it often requires updating other documents already developed. Therefore, it is essential to develop a well-defined procedure that guarantees the coherency among the documents of the project management plan: the configuration management (CM) plan. The PMBOK defines CM as a subsystem of overall project management that deals with the following four aspects: version control, change control, changes notification and changes record (Project Management Institute, 2007). Karlsson and Ågerfalk (2004) propose a meta-method to facilitate configuration work based on pre-made configurations that can be used repetitively. However, configuring a project plan might still be challenging. For example, Ali and Kidd (2014) identify several barriers to effective implementation of CM such us the lack of effective CM tools.

The configuration of a project management plan is a complex system due to the relations among its components. Network theory is a powerful methodology that has been widely applied in complex systems and fields where there exists a strong interdependence within entities, such as biology (food chains, relations among organisms), medicine (disease diffusion), mathematics (graphs), technology (electric networks, transport networks), communication (the World Wide Web, social networks), etc. (Albert and Barabási, 2002; Newman, 2003) and more recently in supply chains (Wen et al., 2013). Moreover, network theory has been used to study other aspects related to project management such as stakeholders influences (Rowley, 1997). However, a review of the literature shows that network theory has not yet been applied to configure a project management plan.

Every project management plan can be modeled as a network, were each node represents a component from a project management plan and the relations among components are represented by links among the nodes of the network. This resulting network is complex as the obtained connectivity differs from a regular network (i.e. lattices) or a nearly-regular network (i.e. a random network) (da Fontoura Costa and Rodrigues, 2008). After the construction of the network, valuable conclusions can be drawn from the application of network theory as this article shows.

In this paper, we present novel approach to perform the configuration management plan based on network theory. We propose a method that yields an appropriate order in the elaboration of the components of a project management plan. The application of this approach will mitigate the difficulties involved in the creation of a project management plan by clarifying the relations among its components and thus helping projects managers to determine a sequence to develop the components of a project plan.

To illustrate the benefits of our method, we have applied it to the most spread standard in the project management discipline: the PMBOK. As it proposes the development of several documents that form a network, it is an excellent standard for testing its applicability. Other authors have previously proposed a list of tasks to be performed while creating a project management plan according to the PMBOK guidelines as, for example, Mulcahy (2013). However, the components of the project management plan and their interdependences were not analyzed.

Notice that the method presented in this paper can be applied to any project, regardless of the standard it follows. Furthermore, it can be used with large and complex projects with independence of the number of components comprising the project management plan.

The structure of the article is as follows. In the next section, we will explain how to construct a network based on the project plan documents proposed by the PMBOK 5th edition. Then, we will analyze the obtained network in order to discuss the most appropriate metric from network theory to determine a sequence for the elaboration of the components of a project management plan. Next, we will illustrate how to obtain this sequence by using *in-degree*, a metric from network theory. Finally, we will present the conclusions of this work and show further applications of our approach.

2. Construction of a network of project plan components based on the PMBOK

The PMBOK 5th edition addresses project management through the execution of 47 processes. The PMBOK describes each of these 47 processes with a number of *inputs* (i.e. units of information required to conduct the process) and *outputs* (i.e. units of information that can be developed by means of the execution of that process).

For example, let us focus on 1 of the 47 processes: 'Define Activities'. The inputs and outputs of this process are depicted in Fig. 1. The aim of this process is to "break down packages into activities that provide a basis for estimating scheduling, executing, monitoring and controlling the project work" (PMI, 2013). So, what information serves as the basis for conducting this process? The PMBOK points out four items to bear in mind (i.e. inputs to this process, Fig. 1): *schedule management plan, scope baseline, enterprise environmental factors* and *organizational process assets*. As a result of the execution of the process, the following documents may be generated (i.e. outputs from this process): *activity list, activity attributes* and *milestone list*. Then, if we were to create one of these outputs, we should consider all the inputs in Fig. 1.

This means that these four elements should already been developed[2] at this point. Now, the question would be: what

[2] According to the PMBOK, there is a strong interdependence among documents. This means a change in one document is likely to provoke a change in other documents. When the PMBOK indicates an input to a process it does not mean that input is necessarily completed. It means that it needs to be taken into account (if it exists). Furthermore, if that input is modified, the outputs from that process should be checked for possible changes.

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