



Model to estimate the project outcome´s likelihood based on social networks analysis.

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Abstract

One of the Key Challenges in the area of Project Management, is definitely, how to set up the best Project Team, regarding several key areas, such as; team experience, flexibility, engagement, know-how, and intra and cross-collaboration, so that Project Success Outcome can be achieved. Such best Project Team is definitely very difficult, if not extremely hard to define, especially when it comes to intra and cross-collaboration matters, where in projects environment, implies an extreme dynamic interaction between project people, throughout all the phases of a project lifecycle. Forecasting, to the possible extent, how that people dynamic´s interaction is a critical factor that can contribute to dictate how a project outcome will look like, is becoming a major concern for Risk Management, in Project Management. In this line of thought, the present work aims to further contribute to this particular area of Risk Management, in Project Management, by exploring a new analysis approach, where it points out its focus towards project People, and how the dynamic interaction of project people, that delivers a project, across its lifecycle, influences or not, a certain project outcome type (failure or success). To provide answer to this question, a heuristic model based on three scientific field pillars (Project Management, Risk Management, and Social Network Analysis Theory), is proposed in this work, which aims to identify a set of critical factors, regarding hoe people dynamically interact across the different phases of a project lifecycle, that are to be associated with project success, and project failure outcome.

Keywords

Project Management, Risk Management, Social Networks Analysis

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1. Introduction

Since one of the most important publication (in terms of the practical application of the Social Network Analysis theory) by the Romanian-American psychiatrist, psychosociologist, and educator, Jacob Levy Moreno (1889-1974) on his work "Sociometric" (1934) [1, 2, 3], and specially within the latest years, the research and development in the field of Social Network Theory, has increased and keeps actually increasing, as well as its practical applications in the most different areas, such as in Organizational Sciences [4, 5, 6, 7]. This arrives due the fact that people have more interest and need, to learn and understand, how people affect and are affected by the environment - the *Network of relationships* - in which they live in, but nevertheless it seems still to be somehow ignored in conventional course materials [8]. Much of this interest is directed to a field, where in general Teamwork is extremely important to achieve results, and in such fields, the study of the relationships between the elements that comprise of those teams, is extremely important, to understand how those relationships can impact the achievement of proposed Objectives. An example of such field is the area of Project Management, where, the Social Network Analysis Theory, it is increasingly being applied within the latest years [9, 10, 11]. Almost everything is to a certain extent connected through a certain type of Network of relationships, and benefits such as, value creation [12], innovation [13], and even survival [14], arise by the ability of interaction of entities that exist within a Network. The way, that a Network, as a whole move across the time, influences the way a Network's components - the Network Actors - interact between them, but the way that those Actors interact, also influences the way a Network moves and evolves across time [15, 16]. These types of relationships are complex, and complicated to understand by nature, and it can't be completely explained trough traditional mathematical methods, rather by methods that are embedded in Sociology Science and graph theory [17]. It is exactly here, that Social Network Analysis Theory, plays a very important role, in bringing light to the problem, usually defined as *social capital challenges* [18, 19, 20]. Pointing out to field of analysis, to a project management environment, the application of Social Theory Analysis Network has never been so intense, and so needed, as it is nowadays [21], where some renowned researchers have been developing approaches to build *Best Team Sets*, that *best* adjust to certain scenarios, function of the response to a certain context, which recommends how to best size a Team when facing a certain Organizational challenge [22]. In Project Management, a critical factor to a successful project outcome is to have a healthy, pro-active and interconnected set of relationships between the elements that comprise a Project Team. Therefore, a pre-preparation of a proper Project Team, setting it based on critical success factors is fundamental to minimize or eliminate unforeseen uncertainties that could turn out into a serious problem to project accomplishment [23]. One of the biggest challenges nowadays, is to understand how people, with their own particular characteristics, interact at group level, and to which extent does this interaction, impacts in project outcome. Some renowned researchers and Institutes (David Hillson the Risk Doctor, and the Harvard Business Review) on the field of Project's and Risk Management, point out three general main aspects that still need to be properly addressed in order to provide more insight and contribute to provide solutions to project management challenges. They are; Principles, Processes, and People [24, 25]. Although Principles and Processes are transversal to people, the People aspect itself, is by far the most complex and still the less explored and understood. Project Management is still done by people. People's culture; know-how; skills; interactions; roles; dynamics, are different, unique and decisive - the focus of the proposed work is People, and the dynamic interaction between people, and groups of people considering the Skills and Roles that, they play during a certain period of time, and to which extent does those interactions, impact Individual, and Team Objectives. It is then fair to state, that more research & development needs to be done regarding the above-mentioned People aspect. In order to provide more insight regarding to such aspect, in project

management environment, a heuristic model based on three scientific pillars (Figure 1); Project Management (contributing with the general structure and concepts of a project Lifecycle), Risk Management (contributing with risk identification and treatment standard-frameworks), and Social Network Analysis Theory (contributing with the tools and techniques to uncover and measure dynamic relational patterns between project people), is proposed in this work.

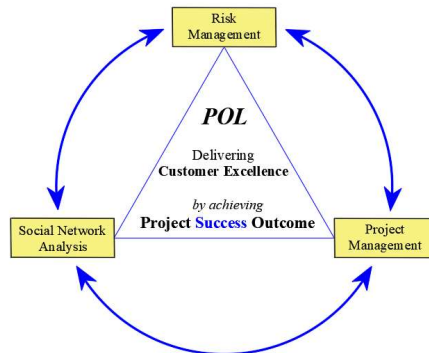


Figure 1 - The Three Scientific Pillars, that form the basis Contribute to the POL Model

In the proposed model, the dynamic Interaction between project people, will be uncovered, analysed and measured based on data from three SITs (project social interaction tools), which are; Mails, Meetings, and Questionnaires; that are used in project management, in order to characterize (look for **RBP**s-repeatable behavioural patterns) five general organizational-employees cooperation types (Figure 2); (a) communication, (b) direct & cross-collaboration, (c) know-how sharing & power, (d) clustering (variability effect), and (e)teamwork efficiency; according to each of the two possible project outcome types - success, and failure. **RPBs** are then considered the critical factors, co-responsible for both, success, and failure project outcome.

2. State of the Art

The application of Social Network Theory spreads through many diverse fields. It spans from Social & Behavioural Sciences [26], Agriculture [27], Health Care [28], Environment [29], Law, National Safety, Criminology, Terrorism [30], Political Science [31], Organizational Science Industry, Management & Leadership [32], and Communication, Learning & Media [33], just to name a few. In the area of Project Management, Project Researchers and Practitioners have been applying Social Network Theory in order to help identify factors and trends, that enable to enhance project management performance, within the latest 30 years. One of the first public research, was done by Pinto & Slevin in 1988, where the first step was to identify, by means of a survey to Project Managers, what were the most critical aspects for success regarding the dynamic interaction of project people across a project lifecycle [9, 34]. This study led later in 2012, to revalidation of the work of Pinto & Slevin, regarding what Critical Success Factors in Projects are, and adding new success factors based on diversity, such as; people nationality (people background) and industry type [35]. In 2001, Mead, developed one of the first project framework based on Social Network Analysis theory to visualize the performance of project teams [36]. A broader approach, to analyse meta-network project performance model, was presented by four of Greek Professors, where the focus goes to the global interaction rather than the single entity [37]. A major breakthrough regarding the application of Social Network Theory in Projects was credited by one of the most influential Project Management Institutes (PMI) in 2012, where it shows the major importance of four subjects of Social Network Theory; Centrality, Structural Holes, Boundary Management, and Tie Strength, regarding project management performance [38]. Since then, many other frameworks in different project management areas have been detailed analysed, proposed such as for project governance strategies [39], and project stakeholder management [11]. Dynamic Predictive Models, that forecast how people will interact and react, when facing different scenarios are being constantly developed and optimized, such as the one presented by the Xing in 2016 at the Microsoft Research Conference [40]. Because project management is a high complex and multi-

scenarios arena, such Dynamic Predictive Models will definitely bring valuable input to the project management area, namely at the stage of setting the project team members that most adapt to certain projects and project lifecycles Phases, enhancing the chances of a Success Project Outcome.

3. Model Framework and Implementation

As already mentioned, a heuristic model, is proposed and will be presented throughout this work, in order to uncover to which extent does the project people dynamic interaction throughout a project Lifecycle influences both, success, and failure project outcome types. The proposed model in this work is called the Project Outcome Likelihood (POL). The model will operate along a set of different project phases, of a Project's Lifecycle. In this work, those project phases (number and designation) are to be adopted by the PMI (Project Management Institute) defined at their latest release - The PMBOK 6th Edition [41]. Nevertheless, the Pol Model is designed to be run, in a finite number of phases throughout a Project's Lifecycle, different of the recommended by the PMI. In this work, the generic phases of a PLC recommended by the PMI will be used [41]. According to the PMI standard, there are four generic Phases across a Project's Lifecycle (Figure 2). They are; Starting the project, Organizing and preparing, carrying out the work, and completing the project.

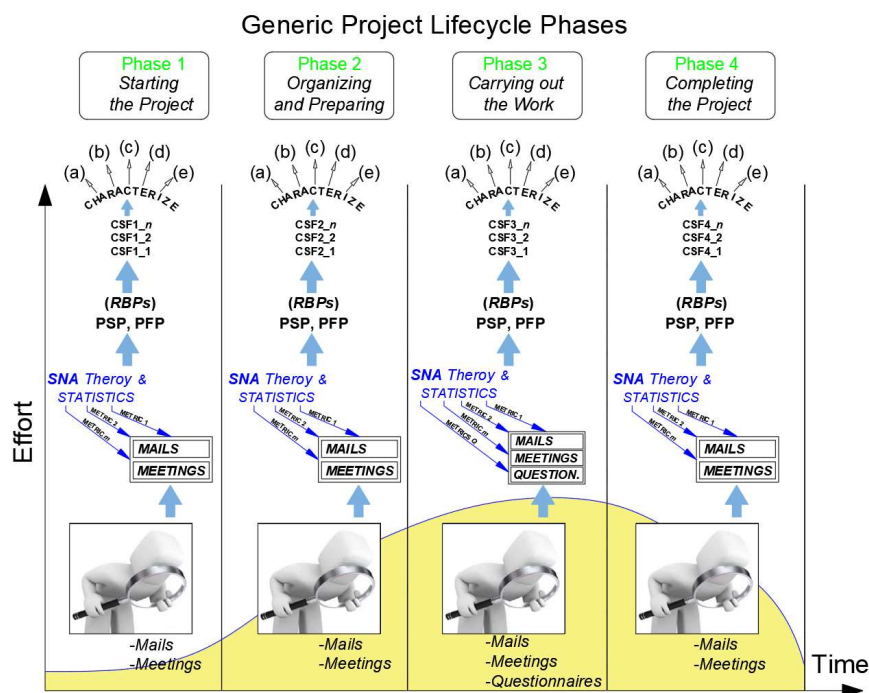


Figure 2- Generic Project Phases of a PLC on where the POL Model functions - POL model analysis structure. Source: Adapted from [41]

At Figure 2, are represented the four different generic Project Lifecycle Phases according to the PMI, and for each phase, is illustrated how the proposed model functions. To understand how the proposed model works, Figure 2, and Figure 3 must be simultaneously analysed. The objective is to characterize the five global collaboration types that occur in projects environments for both, successful, and unsuccessful delivered projects. In other words, the objective is to use the proposed model, to uncover and quantitatively measure, if there are visible and unique differences between, how project people, for example, communicated in projects that were successful-delivered and projects that were unsuccessful delivered. At Figure 2 is displayed the model analysis structure, for each phase of a project lifecycle, and at Figure 3, is illustrated the framework of identifying critical success and failure factors for each of the four project phases illustrated at Figure 2. As an example, a description for phase 1 of Figure 2, and Figure 3 goes as follows; first, one needs to select a same number of successful,

and unsuccessful delivered (closed) projects (Figure 3 a). Second those selected projects, must be able to be divided into the four generic phases of a project lifecycle as recommended by the PMI (Figure 2). For each phase of each of the selected successful, and unsuccessful delivered projects, project related-data needs to be collected by consulting Mails, and Meetings logs (Figure 2). The required information is to be collected according to Table 1. Once that project related-data is collected, it will be analysed and measured by the application of tools and techniques based on Social Network Analysis theory (Graph Theory Metrics), & Statistics (Figure 2, Figure 3 a). The both types of projects outcomes (successful, and unsuccessful), will be independently analysed. For both projects' outcomes (success, and failure) the same metrics will be used. For each set of successful, and unsuccessful delivered projects, a resulting project success (PSP) and failure (PFP) profile will be created respectively (Figure 2, Figure 3 c). This process will be done by averaging all the results for all successful, and unsuccessful delivered project independently. It follows a process of comparison between each calculated metric for the PSP, and PFP. The PSP, and the PFP, contains what are called as RBPs (repeatable behavioural patterns), for both, successful and unsuccessful delivered projects (Figure 2, Figure 3 d). RPBs are the averaged result, that characterizes how project people dynamically interacted throughout the different phases of all selected and analysed project lifecycles for both, successful, and unsuccessful delivered projects. It follows a process of comparison for each calculated metric, between both, successful, and unsuccessful delivered projects (Figure 3 d). If there are crystal clear (unique) different RPBs (given by the metrics results) between successful, and unsuccessful delivered projects regarding how project people dynamical interacted - accessed and identified by analysing mails, meetings, and questionnaires project data-related - then project critical success factors have been identified (Figure 2, Figure 3 e), and the characterization of the five global collaboration types (a) communication, (b) direct & cross-collaboration, (c) know-how sharing & power, (d) clustering (variability effect), and (e) teamwork efficiency - for both, success, and failure project outcomes is completed. If the model does not identify crystal clear differences regarding the five global collaboration types, between successful and unsuccessful delivered projects, it concludes, that the dynamic interaction of project people across a project lifecycle, does not influences a project outcome (Figure 3 d).

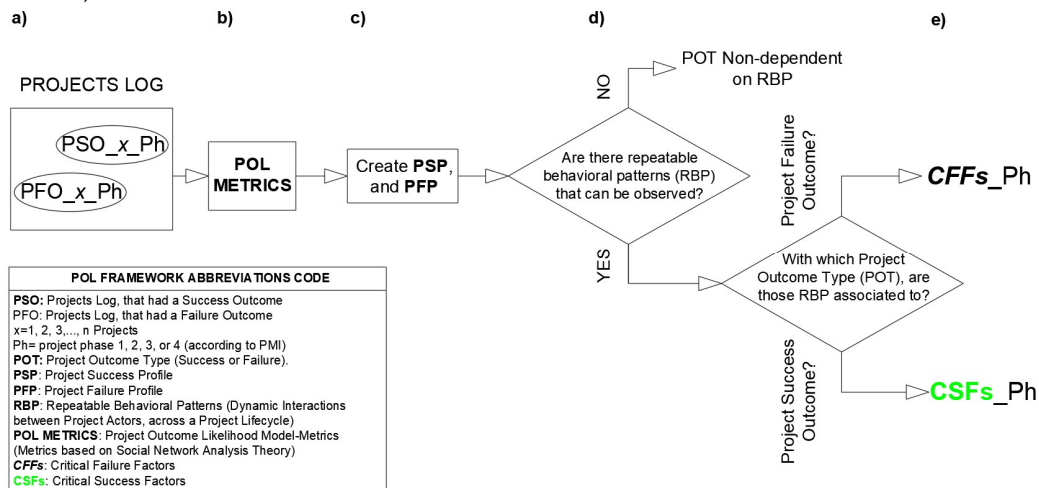


Figure 3-The POL Model Framework

As mentioned, the Pol Model will analyse project related-data of closed Projects (recorded information regarding Project's Actors Interactions across the different Phases of a Project Lifecycle, captured in project Meetings, project Mails exchange, and Questionnaires (Table 1)), that have had a success, and failure outcome. Regarding the project outcomes (success, and failure), the proposed model will adopt the PMI criterion, where it says that, a Project Success Outcome, is a Project that was delivered on Scope, Time, Budget, and Quality - this is known as the Project's Triple Constraint [41, 42]. On the other hand, a Project with a Failure Outcome, is a Project that did not satisfy, at least, one of the previous conditions. In case of more than one RPBs are found, they are to be named according to Figure 2 - where CFS1_1

means; Critical Success Factor 1, for Project Phase 1. The required information for the POL Model presented at Table 1, is to be collected throughout a timeline process illustrated at Figure 4.

Table 1 - SITs and the Required Information to form the POL Model

<i>SIT</i>	<i>Necessary Information regarding one project for Team A & Team B</i>
Meetings	<ul style="list-style-type: none"> - Total number of project meetings in each project phase, across a project's lifecycle - Total number of participants in each project meeting, in each project phase, across a project's lifecycle - Name, Project Official Role, and belonging Team from each of the participants
Mails	<ul style="list-style-type: none"> - Total number of emails sent/received in each phase of a project, across a project's lifecycle that relate to project information matters - Name, Project Official Role, and belonging Team from each participant that sent / received emails project related information. - Categorize emails according*: <ul style="list-style-type: none"> o <i>Mails sent in seeking for help, or advice regarding project information related matter</i> o <i>Mails sent, providing help, or advice, regarding project information related matter</i> <p>*Mails need to be accessed and identified either by their subject or content, as being seeking or providing help type.</p>
Questionnaires	<ul style="list-style-type: none"> - Only to be applied, case a third Team (Team C) takes part at in the execution of a project, and it belongs to one of the sides Team A or Team B, and not both. - Conduct a SNA by applying following two questions to the third Team members: <ul style="list-style-type: none"> o Question 1: <i>If you have a problem, or question regarding (x)*, that is important to execute your project activity, who do you usually go for help, among the project people of Team A and Team B?</i> o Question 2: <i>If you are just about to start the execution of a project activity or task, but you want to make a double check before you go ahead, or even present what you consider to better solution, whom do you turn to, to get approval and final decision among the project people of Team A and Team B?</i> <p>*(x), is a project related activity or task, to be named as the project execution phase occurs.</p>

At Figure 4, is a detailed illustration, of the implementation timeline process of the proposed model throughout the phase 1, called as *Starting the Project*, of a project lifecycle, according to the PMI. Although Figure 4 illustrates phase 1 of a project lifecycle, the structure presented on it, will be used as reference structure for all the remaining project phases. This means, that implementation timeline process presented at Figure 4, is to be replicable to the other project phases, with the respective adjustments previewed at Table 1, regarding the information to be collected. The following description aims to explain the implementation process for phase 1 of a project lifecycle as presented at Figure 4. First, at the very beginning of this phase (usually between project Meetings 1 (E1), and 2 (E2)), a Formal PSN (project social network) Hierarchy needs to be defined, where A and B represent, the two typical sides of PSN - namely the Customer (Team B), and the Service Provider (Team A). This PNS is expected to be the project people from both sides (Service provider and Customer), that will accomplish the project throughout all the phases of a PLC (project lifecycle). This phase starts at meeting E1 and ends at meeting Et. The number of meetings may vary from project to project in each project phase. In each project meeting, is expected that project people from both- or represent - teams A, and B, are present to discuss project related-matters. For each project meeting, the information according Table 1 must be recorded. At Figure 4, are presented some of the possible different participants that may take part in a project meeting. The different people project-roles are illustrated in different geometrical forms (circles, triangles, and so on), and the different people - teams are illustrated in different colours, according to the Legend place mid-up at Figure 4. For example, at project meeting E2, a project person representing an expert role from Team A was present (orange triangle) along with two engineers (blue circles), named 1, and 4 from Team A. At meeting E3, a different project team set is to be observed. In this

meeting, engineer 4, and the expert role from Team A, are no longer present, and this is recorded as OUT / A, in the Actors table under the PBLC. In the same project meeting (E3), a new project person from Team A came in, regarding the previous meeting (E2). They are; engineer named 2, and 3, a project manager, and a other (for this case, the other has non defined role). This is recorded as new entries regarding the previous project meeting, at IN / A, in the Actors table under the PBLC. Still in this meeting (E3) engineer 4 and the expert, who were at the previous project meeting (E2), are recorded as OUT / A, in the Actors table under the PBLC. This variation of project people coming and leaving is represented by the *PSNVar* (Project Social Network Variability). The PBLC (Project Baseline Curve) is the planned curve for the respective phase, regarding the time - effort level evolution throughout this phase.

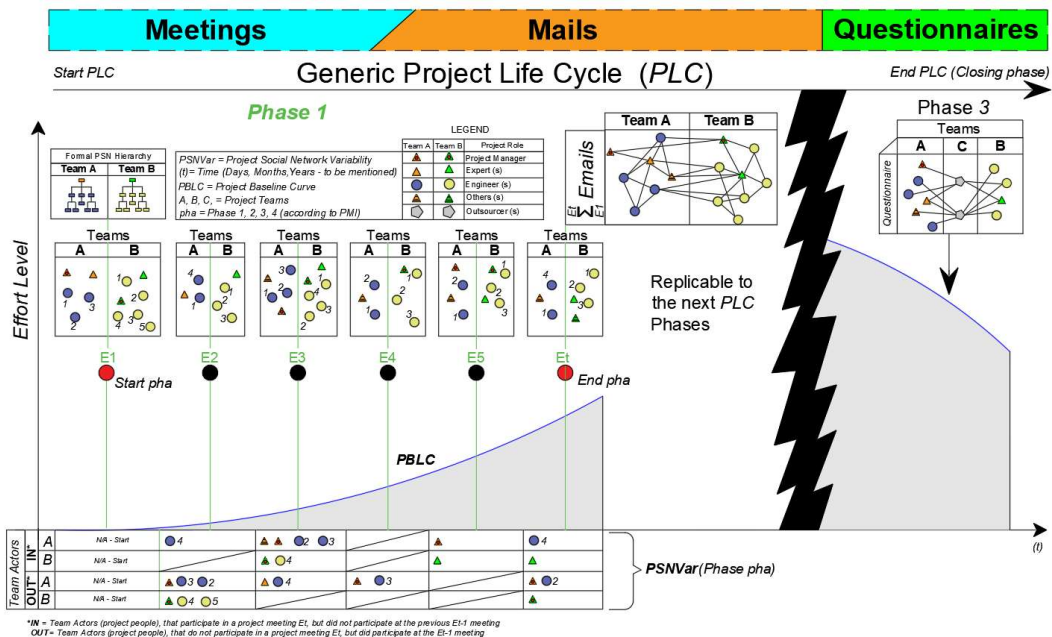


Figure 4 -POL - Implementation Timeline Process

At the end of this phase (like for all the other project phases), all the exchanged project related-data emails, between teams A, and B, are to be collected according to Table 1. This is illustrated at the middle box (Σ Emails) at Figure 4. At Figure 4, is still presented the only phase where information through a questionnaire will be collected according to Table 1. In this phase - Phase 3 - which is denominated as *carrying out the work* by the PMI, it is previewed the existence of a third project team - Team C - for the case of outsourcing needs, regarding project tasks or activities.

4. Model Benefits & Limitations

One of the biggest benefits of the proposed model, is that allows, to trace a cultural actual-working status for each Organization when interacting with other Organizations, that works in project environments. It helps to uncover which is, or which are, the different installed working-cultures within an organization and the associated biases which might have an impact of task accomplishment performance. Knowing how *work gets done* inside an Organization, is the very first step to understand what it needs to be done (case something needs to be done) to improve global performance regarding the way that project people interact. Furthermore, it points out immediately (if there are any) which are the Critical Success Factors (CSFs), that are responsible for a Success Outcome Project-phase, based on how past successful projects were run regarding the dynamic interaction of project people. Parallely it points out what should not be done (CFFs). Once having identified both, CSFs and CFFs, allows an Organization, to a to estimate the project-phase outcome likelihood of an ongoing project, by comparing ongoing project indicators, against the Critical Success Factors previously identifies, as the

model analysed the closed projects. The POL Model is designed to exactly point out what are the deviations between what is the actual ongoing path, and the desired ongoing path, regarding the dynamic interaction of project people. This allows as well, to take accurate and directed correction action case needed, by spending the least amount of efforts. The methods through which data is collected, is to be considered a non-invasive method (except for the Questionnaires on phase 3), which means that to a certain extent, the collected data in Mails and Meetings, is not expected to be biased, or subjected to any preferential degree, or state of mind, of project people, as it is the case when data is collected through surveys (Questionnaires) [15]. On the other side, it requires a certain time and skills to prepare the data as input for the POL Model. Although the POL Model is prepared with a counter-check process, regarding the answers collected through the launch of Questionnaires to project people, the quality of this data, is total dependent on respondent good-will to provide accurate and valid answers. Project-people dynamic interaction chain-break represents another limitation of the presented Model. Many times, happens, that project related information is discussed (interacted), via other type of SITs, such as phone calls, or thought informal corridor meetings. These types are still not capture by the present version of the proposed model.

5. Conclusions & Further Developments

The proposed model in this work (the POL Model), aims to bring, to the project management field, namely at the project risk management strategy, a new approach regarding how to address the risk associated of not achieving a certain desired project outcome, by providing valuable insights, and very likely, an innovative way of addressing the estimation of a project-phase outcome likelihood, ultimately outputting valuable information that can be used to support decision-making processes. The proposed model, contributes, based on historic events, to trace a *modus operandi* of an organization, identifying what may be the Critical Success Factors to a Project Success Outcome, based on the dynamic interaction of project-people. In this form, helps to estimate a project-phase outcome likelihood for a given ongoing project in a certain point in time, by comparing the success/failure profile evolution/performance is, against the actual evolution/performance, by analysing those Critical Success Factors. Furthermore, in a Project Risk Management perspective, the POL Model, is in line with what the latest researches and developments regarding the future of dynamic risk management [24], where, research says, that more importance and attention to typical current practices (repeatable behavioural patterns) should be given [43]. The next step toward the completion of the POL Model, is to be the development of Indicators (POL Metrics), based on Social Network Analysis Theory, that captures the dynamic Interaction between project people, analysis and measures the data collected in Mails, Meetings and Questionnaires (Table 1), which allows the characterization of the five general organizational-employee cooperation types; (a) communication, (b) direct & cross-collaboration, (c) know-how sharing & power, (d) clustering (variability effect), and (e) team efficiency. Ultimately, this will enable to identify and output the Critical Success & Failure Factors to a Success / Failure Project-phase Outcome. To help laying the first steps towards the development of such POL Metrics, a set of strategic questions such as, but not only; are there any existing metrics based on SNA theory that can be adopted to the proposed model? *how many metrics are needed? will it be needed to develop new metrics? will new metrics be developed based on centrality, dispersion or other measures? what social data will be used for each metric? what scale system is more appropriated to be used to characterize real outcome likelihood? what type of likelihood chart will be more appropriated to classify real outcome likelihood?*; need to be properly brainstormed and provided with valuable & meaningful answers.

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