

Tecnologia de informação na análise da eficácia de equipes de trabalho: o modelo de Page-Jones

Information technology in the analysis of team effectiveness: the Page-Jones model

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Resumo

Nas organizações modernas, muita importância tem sido dada às relações de trabalho, incluindo a liderança e motivação de funcionários e o desenvolvimento de equipes eficientes. Em particular, a formação e interação de equipes de alto desempenho tem implicações diretas na capacidade das empresas de aumentar sua produtividade e promover a disseminação interna de sua base de conhecimentos. Apesar da existência de diversos modelos na área de comportamento organizacional que discutem a estrutura e as dinâmicas de equipes de trabalho, desafios à gestão de equipes ainda são lugar comum na maioria das organizações. Neste artigo, um modelo originalmente desenvolvido para a área de Tecnologia da Informação (TI) é aplicado para analisar os problemas que afetam equipes no ambiente organizacional. Os autores utilizam o modelo de projeto estruturado de sistemas de Page-Jones, uma abordagem clássica de modelagem estruturada de sistemas, na identificação e solução de problemas na gestão de equipes de trabalho.

Palavras-chave: Equipes de trabalho. Desempenho de equipes. Modelagem estruturada de sistemas.

Abstract

In the modern organizations, considerable importance has been assigned to working relationships, including employee leadership and motivation, as well as the development of effective teams. In particular, high performance teams and their interactions are extremely relevant to most businesses, given their implications for increased productivity and knowledge sharing throughout a company. Despite the availability of a number of theories on teamwork and team design in the organizational behavior field, team issues continue to challenge most organizations. In this article, a model originally developed in the Information Technology (IT) area is applied to the analysis of the problems that affect teams in the organizational scenario. The authors show how the framework proposed in the now classic Page-Jones structured systems design can be helpful to identify, understand, and solve teamwork problems.

Keywords: Work teams. Team performance. Structured systems design.

Introduction

The production of theory and research on the functioning of groups in the organizational scenario has important implications for the evolution of thought on operational systems and for the development of useful tools for the management of work teams. Work teams are present in all professional areas. A large part of what employees perform in an organization occurs within the context of work groups, and frequently these groups have greater influence on the behavior of the individuals than the organizations themselves [12].

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The literature on organizational systems proposes that structuring activities around work teams can be an efficient management mechanism, as it offers the company opportunities to optimize the flow of information, facilitate multifunctional co-ordination and promote organizational learning [5]. Thus, when teams are well-formed, the synergy between people can increase productivity and help to preserve and disseminate knowledge, not only explicit knowledge, which can be written down simply, but also tacit knowledge, that which is learnt by performing the function and working with those who perform it. In addition to this, a structure marked out in teams can give the organizations greater flexibility in comparison with traditional hierarchies, allowing the companies to adjust with greater speed in response to environmental demands and external contingencies ([8],[5]).

The information era has been marked by profound changes in society and in companies, affecting not only the tools available for administrating organizational processes and the way in which consumers relate to the organizations but also the nature of the work itself. Computer and telecommunication technologies have increased economies of scale and scope, generating profound changes in the companies by reducing the difficulties inherent to geographical barriers, facilitating diverse long-distance business transactions such as operations and distribution processes. In particular, the changes provoked by Information Technology (IT) have also profoundly affected the way in which people work, whether individually or in teams.

With the evolution of the Internet, one of the IT components most present in companies, ways of working originating from science fiction are today perfectly possible. Frequently we observe people working in virtual teams, where the members of the group are located in different continents (or even outside the planet, as in the case of space missions). All of this evolution has one great onus: the resulting risks of errors are much greater and, consequently, more serious. In seconds it is possible to provoke a problem capable of taking a company from the economic pages of the newspapers to the crime pages.

Faced with this scenario of emphasis on work in teams and great technological power available, now more than ever, problems which compromise the efficient functioning of work groups and teams must be detected and avoided. While IT is one of the agents creating these problems, it also offers simple and viable solutions to understand them and avoid them. The problems which affect work teams can be divided into two principal classes: intra-team and inter-team. In this way, the configuration intra-teams is defined as the relationships of interdependence and co-operation among members of the same area of work, and the configuration inter-teams, as the relationships of interdependence and co-operation among members of diverse areas.

It is precisely in this division that we can make an association with the techniques of structured systems design, about which Page-Jones [13] wrote, the model of which has been employed in the area of systems design since the beginning of the 80s. This paper examines the concepts developed by different authors in their structured design and their efforts in analyzing the problems of work teams. In this context, teams can be seen as “modules of structured design”, which possess defined internal cohesion, and which relate with other “modules” through connections.

2 Performance in work teams

Organizational Behavior is the area of study which concentrates the greatest part of the theories on work groups and teams [1]. This area, because of its multi-disciplinary nature, concentrates theories developed in the most diverse fields studying the functioning of groups and teams, such as Psychology, Sociology, Communication and Anthropology. Work teams and groups are meso-organizational phenomena. Phenomena at this level, such as the delegation of authority and leadership, involve more than the actions of individuals (micro-organizational level), and at the same time represent elements which, in conjunction, form an organizational system (macro-organizational level).

Before proceeding, it is necessary to provide an explanation of the terms “group” and “team”. Many authors propose a differentiation between groups and teams, particularly through analogies with sports teams. Work teams are described as formal groups, composed of individuals who act interdependently to reach a common objective [6]. In this sense, all teams are groups, but not all groups are teams, only formal groups. Collaboration between the members of a team is not only desirable but necessary in order to reach the objective [11].

In this way, a summary can be made of the three distinctive characteristics of a team: 1) the members of a team are highly interdependent, and are normally linked together by inclusive interdependence; 2) teams are formed by grouping by work flow, so that their members are responsible for the performance of diverse distinct functions; and 3) aptitude, knowledge, experience and information are generally distributed unequally among the members of a team, owing to biographical differences as regards the training, skills and access to resources of these individuals.

Theorists and researchers have been investigating the factors which affect the performance of teams for many years. Various models of efficiency in teams emphasize the role of *structure* and *processes* which encourage the members of a team to work together in a synchronized way ([7], [10]). Campion, Medsker and Higgs [2] tested a model which includes factors

such as group composition, the design of the task, interdependence between members, group processes and contextual variables. The authors observed in their field research the significant effect of these factors on the productivity, satisfaction and evaluation of the teams. The same model was later tested again [3] on a new sample of professional teams, confirming the importance of the factors proposed, in particular the characteristics of group processes. Cohen and Ledford [4] also observed empirically that the involvement of the members in the team, the design of the task and the characteristics of the group (composition, beliefs and process dynamics) have a significant effect on the performance and efficiency of a team.

This research indicates that the level of motivation of the members of a team can affect the performance of the group, and that well-specified tasks, suitable composition and the support of the organization to the team promote efficiency. However, it seems that there was also consensus that even a perfectly structured group in an ideal organizational environment may not reach an optimum level of functioning if its members do not develop a shared vision of the objectives and processes and, if the co-operation in the group is compromised by lack of mutual confidence and by the existence of intra-group conflicts.

Currently an ever-increasing number of self-managed teams can be observed in companies. The theoretical basis for self-management in work teams has its origin in the model of socio-technical systems, which emphasizes how organizations can combine people and technology in a complex manner to produce results [15]. In these teams, the members interact to create a product or service without any direct supervision. The team members themselves have the authority to make most decisions. It is believed that the members of a team are in a better position to evaluate the consequences of different alternatives, as they have direct knowledge of the work to be performed and the people involved in carrying it out. Enthusiasts for this method propose self-management as a means of empowering employees, increasing their margin of autonomy in making decisions. In these teams, the members are responsible not only for the technical aspects of the work, establishing the rhythm of the activities and undertaking actions to solve problems, but also for the management of the team, planning activities, recruiting new members for the team, designating tasks and monitoring the work.

There is some evidence that self-managed teams can create greater work satisfaction and better results in a company's business [14]. A meta-analysis developed by Macy and Izumi [9], analyzing various studies on the subject, concluded that autonomous and semi-autonomous teams can significantly affect the performance of an organization. However, some experts on the subject state that the success of self-managed teams is, in great part, conditioned by the situational context in which these teams find themselves [4].

3 Using the Page-Jones model to analyze teams

The diverse models and studies discussed so far are a concise summary of an area of study of the broadest scope. As we observed the production of knowledge of teams and their dynamics, we noticed that a myriad of studies have contributed to a better understanding of this organizational phenomenon through the years. However, in spite of so many theories and investigations, there are still questions left unanswered, making the management of problems associated with the management of work teams in the daily organizational routine a real challenge.

In searching for new tools for a more pragmatic approach to the analysis of teams, we found a model, not in the area of Organizational Behavior but in the area of IT, which can offer an interesting and useful alternative for the management of teams and deal with the complexities which surround them. It is the theory of Structured Systems Design. This theory, due to its logically structured standards, can contribute to improvements in the organization of teamwork.

Meilir Page-Jones is a well-known name in the area of IT, despite the fact that almost two decades have passed since the publication of his model. The seminal work of this author was of fundamental importance in "opening the black box" which was the systems area. Based on his techniques, it was possible to design systems adhering to specifications and to evaluate existing projects. He proposed a way of seeing a system in modules, composed of internal instructions and their external relationships. Page-Jones defines modules as collections of program instructions that possess four basic attributes: entrance/exit, function, logic and internal data. According to him, the function of the module is that which it accomplishes for the entrance to produce the exit.

Page-Jones suggests that the greatest problems in the systems are in the internal cohesion of the modules and in their connections with other modules, in other words: intra-team and inter-team. Through the study of the internal cohesion of the modules and of their external links to the other modules it is possible to evaluate whether a system is well designed or not, predicting the possible future consequences. It is not the intention here to explain his entire theory, but merely to initiate a reference for its application in the study of the design and problems of teams.

4 Understanding teams as modules

The Page-Jones theory was developed focusing on computer system design, so a certain adaptation is necessary in order to apply it to work teams. To do so, it is necessary to see a team as a module that: 1) possesses internal elements,

differentiated by function or role in a sequence of events; 2) possesses clear and defined entrances. (An entrance is to be understood as a task request together with specific data); 3) possesses clear and defined exits. (An exit is to be understood as the expected results according to the request performed); 4) should possess relative independence in relation to other modules, in other words, its relationship of dependence should be as small as possible.

In a modular team, the work should flow from the processing of the simple entrance to the production of the final exit in an uninterrupted sequence, with all its members working in harmony to achieve the objective. When there are modular teams, it should be possible to alter a team without affecting the work of the others, giving greater flexibility to an organization.

The decisive factor for a modular team to function correctly is its internal cohesion. According to Page-Jones, cohesion is measured as the intensity of formal association among the elements in a module. This is a very appropriate definition for modular teams as well, because, as will be shown later, a team with low internal cohesion will have difficulty in producing effective results, much less efficient ones.

Also, according to Page-Jones, highly cohesive modules, with strong, genuinely related elements are desirable. However, the elements of a module should not be strongly related with elements of another module, as this would generate a strong connection between the modules. If this is translated for teams, the concept implies that the members of a team should be strongly and genuinely cohesive amongst themselves, in other words, they should be in the team for a clear reason, understood by all. Elements which don't possess a defined role inside the work sequence of the team, can establish relationships with other teams, creating ambiguity.

Adapting the original Page-Jones concept of cohesion for application in teams, the following classifications are possible, from the best to the worst case:

1. Functional cohesion: when the members of the team possess differentiated, complementary and defined tasks, contributing as a whole to reach the team objective.
2. Sequential cohesion: when the members of the team are together because there is a sequence in their work, similar to the concept of grouping for work flow.
3. Logical cohesion: when the members of the team carry out differentiated tasks, which are not necessarily related, although they belong to the same category.
4. Coincidental cohesion: when the members of the team carry out differentiated, non related tasks, without belonging to the same category.

The best type of cohesion is the functional one, where the members of the team contribute to the conclusion of the work with differentiated activities. A functionally cohesive team, in principle, should not suffer problems such as conflict of interests and attributions. Some examples of types of cohesion could be:

- *Functional*: design team of an information technology system, composed of an analyst, one or more programmers, DBA (database administrator), input providers and a coordinator. All have as an objective to develop and implant the system, contributing according to their specialties. Functionally cohesive teams have a strong and defined name, which leave no doubt as to their function.
- *Sequential*: teams of the "shop floor" type, where each one executes one and only one task in a sequence. They don't necessarily execute a specific function together. They are together because their work is performed in a sequence. One example is a team dispatching goods in a store or distribution center. Usually their work has to be complemented by other teams.
- *Logical*: teams of people related by a category, but which exercise independent functions amongst themselves. An example is a section of human resources where each employee deals with a specific task independently of the others (scheduling vacations, up-dating work cards, etc).
- *Coincidental*: they are teams without any cohesion, usually the result of a badly carried out restructuring. The members perform several activities, without any relationship between them. One example is a section of general services, where there is a person responsible for identification cards, another to mark trips, a third to make requests for material etc.

5 Interdependence in teams as modular relationships

The great advantage of applying the Page-Jones model for understanding teams is the visualization of the relationships between the teams, which can become critical if there is a high degree of dependence between them. The relationship between modules in the Page-Jones approach is called a connection, which is defined as the degree of interdependence

between two modules. According to the model, connections must be minimized, i.e., promoting the maximum possible independence between the models.

Adapting the Page-Jones concept of module connections to teams, the following classifications are obtained, ranked from best case to worst case:

1. *Data* Connection: the teams relate exchanging service requests and parameters (data) of execution, receiving only the results. There is no interference in the way in which the service will be carried out.
2. *Common* Connection: the teams share the same document or work on the same object, being able to interfere in each other's work.
3. *Control* Connection: one team, on requesting a service from another, selects the type of attendance or person it wishes to carry it out. In other words, one team knows and controls the functioning of another.
4. *Content* Connection: this is the worst case. It occurs when one team shares resources and tools belonging to another. In other words, it "enters" inside the other team, using people, information or equipment to perform its tasks.

Observe that the problems of excessive connection are related to two factors: lack of internal cohesion in the teams or poor organizational partitioning. Some examples of connection are:

- *Data*: The engineering team requests computer maintenance from the information technology maintenance team.
- *Common*: The telecommunications team and the computer network team work on the company cables and communication appliances. One can cause a problem for the other.
- *Control*: The sales team determines how the goods shall be packaged, how many deliveries shall be made and who controls the process of dispatching an order. The sales team controls the dispatch team, stifling it and assuming responsibilities that are not within its competence.
- *Content*: The planning team enters inside the Accounts department, uses some of the personnel and accesses the accounting documents to prepare a budget proposal. By so doing it can interfere with the work in progress and induce serious operational mistakes.

6 Team design as organizational partitioning

In this paper we define the concept of partitioning as being the division of a group of people into distinct teams. Badly performed partitioning can create teams with low cohesion and a high degree of connection between them. Among the most common causes of badly performed partitioning are:

1. Politics: the need to give positions to certain people;
2. Power: the need to accumulate and control specific functions;
3. Physical space: the need to distribute people among different installations;
4. Cost: the need to unite or separate people to economize on rent, fixed assets and transport;
5. Affinity: the need to unite or separate people due to questions of character, subjective or personal;
6. Lack of knowledge: changes put into effect because of lack of knowledge of the functions or incorrect suppositions (consultants).

How can the causes of the problems in the teams be evaluated to see if they are related to partitioning? The artificial barriers need to be removed from the teams and the functions, which are being carried out, and the flow of data between them examined. In this way, it is possible to understand which functional groups should exist and how they exist in reality. To begin, a Data Flow Diagram of the study area can be created:

1. All of the functions performed by the area must be identified, independent of teams;
2. The functions must be represented as processes (circles), as in Figure 1, and the flow of data as arrows;
3. A function can be primitive, carried out in one sole task, or composed of several other functions. The ideal, for the purposes of this study, is that it comes down to the level of primitive functions;
4. The flow of data must represent all that is passed to a function and all that is produced by it.
5. The rectangles represent External Entities to the process being studied.

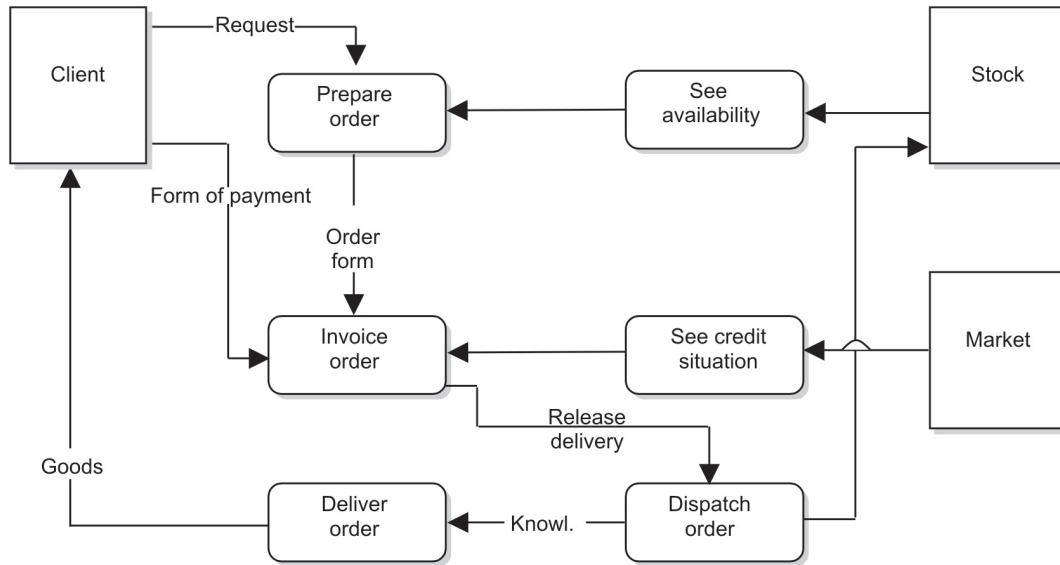


Figure 1: Data Flow Diagram

The flow of Figure 1 is much simplified and would not be sufficient for a complete study. In that figure “knowledge” flows from a dispatch to a deliver order. As it will be shown below, it is also useful to demonstrate another technique proposed by Page-Jones “packaging” the functions in modules, which, in this work would be teams.

Page-Jones also proposes a *transformation analysis*, in which a diagram of the structure of modules is produced from a data flow diagram. With this technique, the Center of Transformation is sought in a diagram of the flow of data in the company, separating all the processes which work to produce and refine ENTRANCES from those which work to produce the EXIT or final product. The Center of Transformation, or the module in which the ENTRANCE begins to become the EXIT, is in the middle of these. The center of transformation must be the principal point of reference for the functions performed in the area. In Figure 2, we have a diagram of modules obtained from the flow diagram of Figure 1.

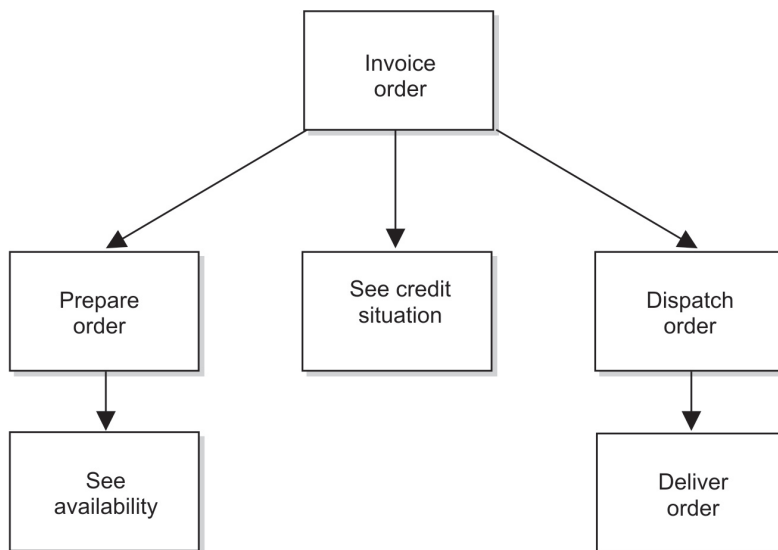


Figure 2: Diagram of modules

In the diagram of modules, the function which represents the center of transformation is placed at the highest hierarchical level, with the other functions underneath it, whether ENTRANCE or EXIT. The arrows now represent connections between the modules, pointing in the direction service request - service provider.

In this representation we can join teams together or separate already existing ones, so as to attempt to create functionally cohesive teams with a low degree of connection among them. An example would be to join the functions “See availability”

and “Prepare order”, as both form part of the task of preparing an order. However, if it was decided to unite “See availability” and “See credit situation”, it would mean creating a team with low cohesion (logical or coincidental), as these functions are neither complementary nor dependent. In this way it is possible to observe the degree of connection between modules through the parameters of the orders. If they contained instructions, there would be a suspicion of control connection, as explained above.

When the diagram of the modules has been concluded, the ideal structure obtained can be compared with the existing one, seeking to identify problems in the partitioning of teams.

7 Conclusion

This paper constitutes a post-positivist analysis, inspired by the observation of authors on diverse problems of teamwork performance in modern organizations. After reviewing the literature on the performance of teams in its most obvious *locus*, i.e., the theories and research which traditionally inform the area of Organizational Behavior, an investigation in literature on Information Technology was carried out with the purpose of identifying alternative theories and models which could be applied to the management of teams. This initiative originated from the experience of the authors in the management of IT design and development teams, a practice which led to the identification of the Page-Jones model, a structured systems design technique, as a tool eminently applicable to the analysis and diagnosis of problems associated to the management of teams. This analysis makes a parallel between the recommendations in the area of team management and the Page-Jones theory. Adapting the Page-Jones vision to the world of teamwork, the analysis reviewed the discussion on intra-team and inter-team factors which affect the performance of these groups, and the partitioning or organization of work areas. Using the concepts presented of cohesion, connection and organizational partitioning, it is possible to analyze and diagnose the problems observed in work teams, both intra-team (cohesion) and inter-team (connection). Teams with low cohesion normally present low productivity due, among other factors, to:

1. Lack of orientation to a common objective (each seeing only his/her part);
2. Problems of conflicts of interest and responsibilities;
3. Excessive dependence of external resources (high degree of connection).

Teams with a high degree of connection also present low productivity, the causes of which may be:

1. Communication in more than one stage (send, receive, send again, receive etc);
2. Interference in other teams can lead to delays and errors;
3. Interference by other teams in the work can create conflicts and result in duplicated work.

Finally, areas where partitioning was badly performed also present low productivity, some causes of which may be:

1. Dissatisfaction of the members of the teams (a wish to belong to or make use of the benefits of other groups);
2. Teams with low cohesion;
3. Teams with a high degree of connection.

An area or organization should be partitioned so that its objectives can be reached. However, the activities must be grouped logically, with both authority and responsibility adequately defined. This being the case, the Page-Jones structured design techniques meet this need, organizing the modular teams and defining their relationships in a practical and objective manner.

Thus, in a simple and systematically structured way, problems with teams can be analyzed and their causes established. In the same way, the application of the concepts proposed in this work can help to design more productive teams. Cohesion inside a team is always desirable, provided that the norms of productivity in the team are positive, in other words, provided that the members of the team share common goals, which aim at high performance. Nevertheless, it is important to stress that a certain degree of interdependence between work teams is inevitable in diverse organizations. However, initiatives which optimize interaction between work groups, with the aim of improving organizational processes, are fundamental to allow these organizations to achieve a high degree of efficiency.

8 Recommendations for future studies

This paper presents a first approach in the sense of detecting and explaining problems in and among work teams and groups in organizations, through the application of structured design techniques proposed by Page-Jones. The ease of application is due to the structured and systematic focus adopted in the original theory. However, there still remains space for studies which are designed to identify structures more compatible with the reality of meso-organizational behavior. Through empirical studies, the practical results and the applicability of this proposal can be more closely verified, which would also offer an opportunity to refine the application of the Page-Jones concepts as an alternative for the efficient management of high performance teams.

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