Florin POPESCU
Doctoral School - Entrepreneurship, Business Engineering & Management
University "Politehnica" of Bucharest, Romania

RESEARCH ON COMPLEX, LARGE INDUSTRIAL PROJECTS IN TRANSNATIONAL ENVIRONMENT

Theoretical article

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Abstract

More and more projects from different industrial sectors developed in transnational environment are becoming more characterized as "complex". In recent years, there has been much discussion and controversy about the complexity of the projects, and, despite what has been written and said in various papers, journals and professional conferences, more confusion than clarification was created, complexity of projects being interpreted differently from one author to another.

Most of the literature studied is based on linear, analytical and rational approach, focusing on the size of project management planning and control and actually less on projects that are characterized as taking place and grow into a dynamic socio-human environment in a continuous change. This study represents a critical review of existing theoretical models found in literature, highlighting their limitations.

The output of this literature study represents an integration of different approaches concerning complexity under one umbrella to provide a common understanding of the evolution of this concept.

INTRODUCTION

This research represents a literature study on complexity of complex, large industrial projects developed in the transnational environment in order to understand the place and role of complexity in project management within the globalized era in various industry sectors. It also presents discussions on terms of complex and complicated descriptions and analyzes in detail the models of complexity proposed by various experts. In the second part of this study an overview of the essential characteristics of large industrial projects in the light of experience of the authors in the literature is presented. It will also look at how relocating of production in transnational environment contributes to the complexity of projects.

UNDERSTANDING THE COMPLEXITY OF PROJECTS IN RELATION TO EXISTING THEORETICAL MODELS

In the globalized world we live in, we realize ever more that nothing is simple, the term complex becoming increasingly used, although complexity has always existed as part of our environment and as such many fields have been dealing with complex systems. As said, Weck, Roos and Magee (2011) in "Engineering systems: Meeting Human Needs in a Complex Technological World," modern life in a globalized world is governed by engineering complex systems, responsible for carrying out vital functions of society, such as eg. modern communication systems, integrated transport systems, health systems, systems for generation and distribution of energy, etc ... These systems are not purely technical systems, they must be seen and addressed as socio-techno-economic systems where people are interconnected with technology, becoming dependent on each other. These systems are designed, developed and disseminated by means of various projects and/or programs.

"Complex" comes from the Latin words "cum" which means together, bound, and "plexus" with the meaning of braided or wrapped. The concept of complexity is an area that has attracted the attention of both academics and practitioners, which prompted me to analyze different aspects of complexity to understand the nature of complexity and uncertainty generated by them and finally how they impact management of large industrial project in transnational environment. An important aspect considered in analyzing the complexity of the projects was not only understanding complex concept, but the distinction between complex and complicated. Thus, according to Webster dictionary the term "complex" is defined as "being composed of two or more parties" and complicated - as "something difficult to analyze or clarified."

Practitioners often describe their projects as simple or complex when discussing management issues, accepting that conventional methods and techniques are not always sufficient. Trying to understand the requirements of modern management projects and the various situations facing their development, the term complexity gradually became a point of reference. I consider that is too simplistic to classify projects as complex or simple. Hence the importance of this study is to identify the source/sources of complexity, scale and complexity of project management implications. In this literature research, I concentrated my efforts for a detailed analysis in a chronological manner of complexity models offered by different experts in the field as Turner and Cochrane, Ralph Stacey, Baccarini, Terry Williams, Kahane, Reminghton and Pollack, Gerald, Adlbrecht, Mayle, Girmscheid and Brockmann Haas, Bosch - Rekveldt, Mayle and Williams, Kothler and Caslione, Khan and Gul, PMI -2013, Pigagaite, Silva and Hussein, Zhu and Mostafavi, Botchkarev and Finnigan. But before analyzing these patterns suggested by the authors mentioned above, it is important to understand what represents a model. Most dictionaries define a model "... as representing a simplified description of a system or complex entity as to facilitate the calculations and predictions."

Williams (2002), identifies the key attributes of a model as follows:

• a model represent or describe something real. This implies that a model must be based on a theoretical definition, which defines relationships between concepts;

• a model simplifies real entity. Construction of a model has a generally purpose, make calculations or predictions about how the entity will behave.

Selected models most relevant in the context of project management will be analyzed in a chronological order of their appearance.

Matrix goals/methods proposed by Turner and Cochrane – 1993

One way of assessing the potential complexity of a project was proposed by Turner and Cochrane (1993) who developed matrix goals/methods. Authors, Turner and Cochrane, classified projects using two main parameters:

•how well defined project goals, and

•how well defined methods to achieve goals.

Authors have identified four types of projects embarked on a common matrix, as follows:

• type 1 - projects methods/goals well defined and correctly understood by the project participants, the project manager having the role of "directional".

• type 2 - projects that have aim/aims correctly established, but the activities and methods are

poorly defined. In this case, the authors argue that the planning process should be conducted on the principle of wave motion as the information becomes available and the project manager role is in this case the "guide".
• type 3 - projects with poorly defined goals, but well-defined methods are those projects that are planned in stages over the life cycle and the role of the project manager is then the "expert".
• type 4 – projects with poorly defined goals and methods are perceived as typical for research and development projects.
Concluding in a critical manner, the model proposed by the authors can serve only as a supplement or support for a more robust model. I state this, because the emphasis in this model is placed only on goals and methods, authors avoided to consider critical issues of complexity, such as appearance uncertainties and connections, having failed thus to analyze interdependencies between elements of a complex, large project.

Stacey's approach – 1996
A useful map to navigate into complexity space is found in "The Matrix Stacey - 1996'. According to author, the purpose of this matrix is to correctly identify where process efficiency and effectiveness are maximized. In this matrix, Stacey analyzes the complexity in terms of two dimensions:
•certainty;
•the agreement of stakeholders in the project.
This model provides a method for selecting appropriate management approaches in a complex adaptive system, emphasizing the choice between approaches in management or leadership decisions. The matrix proposed by Stacey shows the existence of 5 different areas that will be analyzed sequentially through the implications of project management.
Zone 1 - Simple: Near agreement, almost certainty. According to author, this area falls simple projects where there is a rational decision-making process, agreement and clarity regarding the scope of the project. Parties involved agree and realize what it takes to be part of the project. Traditional management approach works best in this area, as evidenced by other authors.
Zone 2 – Complicated: Far from agreement, almost certainty.
This area falls projects where there is an agreement on how to obtain the results, but exit disagreements on the desired results. It is the area where neither plans nor mission seem to work together and as such we need to create coalitions, negotiations and compromises. Progress towards the goals is superficially directed by accepted political motivations and hidden agendas.
Zone 3- Complicated: Near agreement, far from certainty.
This area means the project goals are accepted but we do not know for sure how they will be achieved. Uncertainty about goals and objectives often causes changes and lead to an increase in structural complexity. Traditional management seems not to operate without the existence of predetermined plans.
Zone 4 - Anarchy: Far from agreement, far from certainty. It represents circumstances where there is agreement on the draft plans and while there is a high degree of uncertainty, resulting collapse or anarchy. Traditional methods of planning, vision and negotiation are insufficient and as such the only viable strategy to avoid can give results, but in the short term.
Zone 5 - Complexity: At the edge of chaos. This area, called the Stacey as complex, other authors using the term the edge of chaos, is an area characterized by high creativity, innovation, where new methods and modes of operation are created based on traditional management approaches. Concluding again in a critical manner, the matrix proposed by Stacey, mainly centered on the changes can be helpful in choosing different approaches to leadership, but this matrix does not go away in analyzing interdependencies.

Baccarini's approach -1996
Baccarini defined complexity of the projects as "... composed of several parts, such as tasks, specialists and other components under different degrees of networking..."
He describes the complexity of the projects in terms of organizational and technological complexity, as follows:
•organizational complexity: Bacarini differentiate organizational complexity into two categories: vertical and horizontal. Vertical one refers to the hierarchical structure of the organization, such as the number of hierarchical levels, while the horizontal is separated into two categories: organizational units and structure tasks, first referring to the number of departments or teams, and the one in end to the division of tasks that are after Bacarini routine tasks and specific tasks. In terms of interdependence, organizational complexity is given by the interaction of the components of the project.
• technological complexity refers to a variety of technologies involved in achieving goals and objectives interim/final project. Continuing conclusions still in a critical manner, I can say that it is surprising that Bacarini ignores the concept of uncertainty, although other authors before him tackle the concept.

Terry Williams's approach - 1997, 1999
One of the best-known authors cited in the literature is Terry Williams witch sharess the same vision of Bacarini regarding the complexity of the

projects, bringing additional dimension called uncertainty as basic dimension of complexity.
Structural complexity refers to the number and types of items, the differences between them and the number and degree of differentiation in relations between them. A simple example is represented by the stakeholders in a project: a project becomes more complex as the number of stakeholders is higher, and if the differences between stakeholders are growing. It also becomes more complex if the number of relevant relationships between stakeholders is growing, and the types of relationships are becoming increasingly different (eg, cash flow, information flow, material flow, flow control, etc. ..). Summarizing, number, type of elements and their relationships determines the structural complexity of a project. Also, Williams concludes that the complexity of projects is increasing and is attributed to two main causes:
- increasing complexity of global products;
- reducing the execution time of projects.
Concluding Williams model analysis, I can say that this model is still too simplistic because it ignores the effects of social interactions and their contribution to the complexity of the projects. As stated in the introduction to this chapter, complex systems must be analyzed as socio-techno-economic systems, not only technical systems.

Hassan and Kahane approach – 2005
Unlike the authors analyzed above, Hassan and Kahane addresses the complexity as deeply rooted in the social environment. The authors distinguish complexity in three different ways:
• Dynamic complexity: a system may be analyzed with reference to its structure as discussed above. But this gives us just a "static" snapshot about a particular point in time. It is important to analyze and understand the system in terms of its behavior and how it changes over the time. According to authors, some of the most important aspects of complex projects relate to their dynamic nature: What is the planned duration of the project? How will evolve and change as requirements stakeholders?
When we increase and decrease staffing levels and in which areas? And how possible emerging behaviors such as organizational strength, can influence and change a project?
• Generative complexity: this type of complexity is characterized from the point of view of Hassan and Kahane, by situations where can not predicted and calculated a solution in advance based on what has been achieved or worked in the past. In this situation future is unfamiliar and can not be determined.
• Social Complexity: authors refer to the fact that different people with different perspectives and interests are involved and participate in creating and implementing solutions. Hassan and Kahane introduced for the first time in literature the "U" methodology to address the challenges of complexity. According to the authors, the use of process U, a member or a project team adopts three activities: detection, reflection, achievement.
Continuing this time with a critical approach, it can be said that, like matrix Stacey, Kahane's emphasis is on change and conflict resolution. Kahane and Hassan admit that their approach may not always be applied, leaving many unanswered questions regarding structural and technological complexity. Consequently, I consider this model as incomplete because does not address all elements of the complexity spectrum of projects.

CYNEFIN Framework – 2007
Another interesting framework for proper study of the complexity of the project has been developed by Snowden and Boone (2007) called Cynefin Framework that allows the executive of project to see things from different angles, to assimilate abstract concepts and address the real problems facing the project, and opportunities. The framework proposed by Snowden and Boone is focused on five different contexts based on cause-effect relationship.
It is important to note that Snowden and Boone identified complex systems by behavior rather than by characteristics, cause and effect and the unpredictable nature of complex systems representing typical examples.
Concluding in a critical manner, the classification made by the authors is too simplified, the model being centered primarily through the perspective of leadership and not on identifying the factors that lead to complexity.

Geraldi's and Adlbrecht approach – 2007
A pragmatic approach to the complexity of projects is carried out by Gerald and Adlbrecht in 2007. The model developed by them has upon in Williams' theory, but bringing 3 new terms: complexity of chances, circumstances and interactions.
The two authors do not intend to define or explain the complexity or provide managerial solutions, they present model complexity term as perceived in reality and practice.
• complexity of a project given by the chance: results from the novelty given by a product or the development of new technologies, that namely what is done for proper first and bearing the uncertainty in it, and ways and means to achieve it are not clear. Lack of clear information leaves multiple options to project teams and/or solution to a unique problem and in extreme situations where feasibility or success are vague, chance is that makes project teams to go to success.
• complexity of reality/circumstances: occurs when we deal with a lot of interdependent information.

Certainly, there is no time for the full analysis and understanding of information, but decisions must be taken. Therefore, according to the authors, the challenge is to maintain a holistic view of the problems and not remain lost in the details.
• complexity of interactions: the third type of complexity is perceived in terms of interactions within the organization or in external relation to customers. The complexity of interactions could come from the existence of two or more locations from politics, from culture or from transnational environment.

Model proposed by Reminghton and Pollack – 2007.

Other important contributors to the study of projects complexity are Reminghton and Pollack that provide us a starting point for establishing the typology of complex projects. Authors emphasize that a clear distinction on the type of project helps in the selection of appropriate management methods. Remington and Pollack said that projects accurately defined in terms of purpose and control, can be seen as simple systems that interconnect hierarchy, communication and control well-established, while large projects presents attributes as transition phase, adaptability, emergence and sensitivity to initial conditions, which are characteristics of complex adaptive systems.

Main characteristics of complex adaptive systems according to several authors and synthesized by Remington and Pollack are: hierarchy, control, emergence, transition phases, non-linearity, adaptability, sensitivity to initial conditions and low predictability. Compared to the authors analyzed above, Remington and Pollack propose to study four types of project complexity:

• structural complexity;
• technical complexity;
• directional complexity;
• temporal complexity.

Structural complexity: According to Remington and Pollack, it runs from large projects which are typically separated into separate smaller tasks and subprojects. Specific complexity of these types of projects is apparent from management and keeping a huge number of tasks and activities interconnected. Large engineering projects, construction projects, IT, projects in defense sector seem to experience quite often with such complexity, structural complexity.

Technical complexity: this type of complexity is found in projects that face technical or design issues associated with new products that have never been produced before, having no precedent or tested techniques. This type of complexity arises from the uncertainty regarding the outcome of several interrelated design solutions. According to authors, the challenges of project management on this type of complexity is facing critical phases of design, managing contractors on providing technical solutions with stakeholders' expectations. In practice, architectural projects, industrial design and new product research-development face such complexity, technical complexity.

Directional complexity: this type of complexity is common in projects that are characterized by goals and objectives overshadowed by the unclear meaning and hidden agendas. This type of complexity arises as a consequence of ambiguities and uncertainties attached to the multiple interpretations of project goals and objectives. The challenge of project management tends to be associated with this kind of complexity regarding necessary time allocation during the initial phase of the project for understanding organizational policies and relationship between the various structures involved in the project. The authors point out that, knowledge of the political and cultural sensitivities are two fundamental capabilities needed to manage projects which face such complexity.

Temporal Complexity: is encountered in projects characterized by changes in strategic directions, which at one time are beyond the control of the project team and gives rise to uncertainties about the next day constraints and even the future existence of the system. Unexpectedly legislative changes, rapid changes in technology that make a redundant project are some of the typical situations where temporal complexity strikes.

In conclusion, authors have managed to synthesize relevant models of complex project management, their approach representing an approach away from the traditional approach to project management techniques. This model sets a basis for other more recent models, which are detailed as follows.

International Centre for Complex Projects Management -2007

In 2007 was founded the nonprofit organization - International Centre for Complex Projects Management (ICCPM) - formed with the support of the Governments of USA, UK, Canada, Australia, Singapore and major global corporations such as BAE, Boeing and Lockheed Martin, RAYTHEON etc. ... in order to manage and successfully carry out complex projects, both in industry and government organizations.

ICCPM first forum, held in Washington in December 2007, conducted a series of assessments on complex projects, as follows:

• projects characterized by uncertainty, ambiguity, dynamic interface with powerful political or external influences;
• projects developed, usually for a period exceeding cycle technologies involved;
• projects that can be defined by "effect" no by "solution".

Girmscheidand Brockmann's approach – 2008
Authors have analyzed the inherent complexity of large-scale industrial projects (Large Scale Engineering Projects - LSEP) as representing the degree of multiplicity, interdependence and consequently impacting the decision-making process. In the organizational context it refers to the multiplicity of functions in LSEP differentiation, as the players involved, clients, designers, contractors, external or internal. Interdependencies define the interaction between the system and subsystems and consequently impact related to the complexity arising from the decision making process.
According to authors, there are five different areas which contribute to the complexity LSEP such as:
• complexity of tasks - refers to the density of activities in a given space and time frame;
• cultural complexity - refers to the history, the experience of different groups that their efforts in achieving the project objectives;
• cognitive complexity - analyzed at group or individual;
• operational complexity - the extent to which organizations are independent in defining project goals for operations;
• social complexity - refers to the number and diversity of actors who communicate and work with each other.

Maylor, Vidgen and Carver's approach – 2008
A reference model regarding complexity of the projects is provided by Mayle, Vidgen and Carver in 2008. The model proposed by the three authors is known as MODeST, which stands at 5 dimensions or characteristics of the complexity of the projects that managers need to consider: mission, organization, distribution, stakeholders, project teams.

Haas's approach -2009
In his book, "Managing complex projects", Kathleen Hass reveals several important characteristics of complex adaptive systems, such as:
• co-evolution;
• sub-optimization;
• connectivity;
• simple rules;
• repetitive;
• self-organization;
• systems to other systems.
The same paper also encounters a spider diagram that can be utilized to generate several profiles of projects complexity. The purpose of this graphic is intended to help identify whether a project is "independent" (low complexity), moderately complex or extremely complex. The chart is based on eight areas of uncertainty encountered in developing large complex projects:
• Cost / duration;
• Team composition and performance;
• Emergency / flexibility;
• Clarity problems / solutions, complexity I.T.
• Volatility;
• Political sensitivity / multiple parties involved in the projects;
• Level of organization / business changes;
• Risks, external constraints, dependencies.

Kothler and Caslione's approach – 2009
Kothler and Caslione in "Management and marketing in the age of turbulence", said the projects today identifies risks and opportunities which require the development of alternative strategies to be implemented in a timely manner. According to the authors only a management strategy focused inward from exterior enables a reaction rate in a timely and efficient manner. Speed of response is crucial in the "new normal normality", and companies and projects based on traditional hierarchical organization can not have an effective response speed and in a timely manner. Therefore, operational and organizational flexibility are prerequisite for a large company / project in transnational environment to become flexible in terms of management strategy. In conclusion, the transition from a functional organization to organization based on departments around interoperable teams oriented to goals and objectives contribute to proactive answers and solutions in situations of turbulence.

Bosch- Rekveldt et. al approach -2011
In their research "Grasping project complexity in large engineering projects", Bosch - Rekveldt and collaborators have created a new framework for understanding the complexity of projects called TOE, the technical dimension (T) includes potential causes of complexity in terms of scope and content of the project, organizational size (O) includes potential causes of complexity in terms of internal organization of the project, and the external dimension (E) includes potential causes of complexity in terms of external environment problems.
In the case studies in this paper mentioned above, authors have identified the main causes for each size in part, as follows:
- size T: lack experience with the use of technology, uncertainties regarding the project;
- size O: unavailability of resources and skills, intolerance to different methods and management technics, types of contracts, lack of experience stakeholders;
- size E: the number of stakeholders in the project and a wide variety of prospects.

Gerald, Maylor, Williams's approach – 2011
In "A systematic review of the complexities of projects" some of the most active authors in the complexity of projects field, Gerald, Mayle and Williams have made a summary of the academic literature that addressed over time complexity of the projects and proposed an "umbrella" framework including authors contributions until 2011. The three authors have identified and regrouped types, attributes and indicators of complexity around five major categories of complexity projects, as follows:
• Structural;
• Dynamic;
• Uncertainties;
• Temporal;
• Socio-political.

Gul and Khan's approach – 2011
Authors have developed a model to address complexity of projects based on the model proposed by Williams. Authors stated in "Towards a comprehensive model of project complexity" that Williams model is too simplistic not only because ignores the effects of social interactions, but also their contribution to the complexity of the projects. Moreover, authors have extended the model of "uncertainty" proposed by Turner and Cochrane, adding the uncertainty brought about by the external environment. This model proposed by the two authors allow mainstreaming social projects as an important contributor to the complexity of the projects in a globalized world without trade and financial barriers.

Project Management Institute -2013
Perhaps themost famous work used by project managers and project teams around the world that address the complexity of the projects is the work of "Project Management Body of Knowledge - P.M.I. -2013 ". The complexity notion is mentioned and used in this reference for project management for 21 times. Also, the adjective complex is used 16 times. The complexity term is used in PMI -2013 regarding the size of a project, the concept of size being in turn defined, but as an adjective for products, services, results, processes. PMBOK provides a summary of important characteristics of the projects that are in close correlation with the notion of complexity, as follows:
• the number of phases of a project (PMI - 2013, page 41);
• the content of the project management plan (IMP - 2013, page 74);
• control level applied (PMI - 2013, page 96);
• the level of detail for work packages (PMI - 2013, page 128);
• the accuracy of cost estimates (PMI - 2013, page 205);
• the need for formal and informal assessment of project performance (PMI - 2013, page 282);
• the number of stakeholders in the project (PMI - 2013 page 394).
Following the brief analysis, can be said that the term complex is used to suggest the scale of the projects. Lack of clarity in PMBOK on the nature of the complexity and understanding of it can negatively impact project management practitioners.

Pigagaite, Silva and Hussein's approach -2013
In "Sources of complexities in new product and process development projects", the authors examine the sources of complexity in the development process of new products. Authors stress that the major sources of complexity of projects to develop new products and services are represented by the interdependencies between tasks and project updates. The authors identified 5 categories of complexity sources, as follows: staff diversity, uncertainties, technological novelties dependency and customers interference in the development process of new products.

Zhu and Mostafavi's approach – 2014
According to the two authors, complex engineering projects consist of interconnected processes, stakeholders in projects, resources and information. Authors argue that traditional project management that identifies complex engineering projects as monolithic systems fail to take into account the dynamic interrelationships and interactions between the different entities and networks in complex projects. In their research, other systems within the system aim to create techniques and tools for integrated management of complex engineering projects. For developing the authors used two principles:
• abstraction at the basic level;
• multi-level aggregation.
At the basic level, complex engineering projects are abstracted as different entities (human agents, and information and resources). At the higher level (level of work performed, the processes and the entire project level), various entities are aggregated by their dynamic interactions and interdependencies.
By using frame SoS (System of System), new ways of assessing impacts of projects such as the attributes of entities at baseline and emergent properties at the project level can be exploited. The proposed framework provides an integrated approach to a bottom-up assessment of performances in projects under various scenarios of uncertainty.
Concluding in critically manner the analyze of SoS model, a limitation of the framework proposed by the two authors is that it is mainly used in

construction projects and can not be applied to large spectrum of projects.

Botchkarev and Finnigan's approach – 2015

Based on the finding that complexity has become an inherent attribute of any project, the intention of the two authors was to define the complexity so as to facilitate construction of an early warning system to enable the project manager/project teams to focus on areas and critical aspects of projects in order to prevent risks and mitigate problems that are related to complexity. Like other authors such as Gorod, Sauser and Boardman (2008), Zhu and Mostafavi (2014) investigate and describe the projects as "systems of other systems."

First, the external environment implies, according to the authors, internal and external stakeholders of the organization responsible for the project, with the mission, goals and objectives related to end-users.

The second system is the internal environment of the project that includes activities required for project development and implementation.

The third system is the final product of the project, which is different from project to project. These three interrelated systems are used by authors to group attributes of complexity.

Continuing my conclusions in a critical manner, the study of two authors focused on identifying attributes of individual complexity, not having in mind that projects in real life are prone not only to one or more individual attributes, but a combination of complexity attributes with impact difficult to predict.

LARGE SIZES INDUSTRIAL PROJECTS

Various terms are used to describe large-scale projects, such as large projects, major projects, giant projects or mega-projects (Ruuska et al, 2009). Searching for terms such as large projects, major projects, mega-projects in the IJPMJ and PMJ, can be noted that in the 80s and 90s almost no papers/articles that address these terms, but since the 2000s, with the explosion of technology and the expansion of globalization and relocation of industrial production, interest in these concepts has increased. However, existent literature as regards large projects remains quite poor (Ruuska et al, 2009), though with the relocation of industrial production, projects with large spanning several continents / countries became increasingly popular (Sanderson, 2012).

Inspecting megaprojects few definitions and approaches in the literature in a chronological order of appearance items/scientific works, one can observe a shift of interest from the area of project costs to the organizational structure of megaprojects. Thus, in one of the most recent publications, Sanderson (2012), highlights the contribution of shareholders, customers and contractors to the complexity of large projects, the relationship between client/shareholders and contractors as a result of the need for transparency and accountability them.

Studies offered by the authors analyzed above on large projects contain some common elements such as:

•time - projects that span a period of time, usually more than a decade;
•cost - estimated cost (here including human resources and equipment needed) are in the millions of dollars/euros;
•ownership - private, state and/or mixed;
•major risks and uncertainties;
•technological innovation;
•impact of social, political, economic and environmental;
•changing priorities during the projects development;
•multiple locations in different continents/ countries.

All these common elements inherently lead to a high degree of complexity of large projects from transnational environment. According to the same authors, project size is determined by many variables, such as:

• aim of the project - the more widely, the project will be more extensive;
• number of organizations involved in the project;
• the number and severity of problems met in project development, which is reflected in the risks and uncertainties;
• project life cycle - as the time horizon is longer, the projects tend to be larger and more complex.

A large project is usually composed of several sub-projects related, multiple locations in different countries/continents, multiple organizations of various sizes and complex tasks to perform. Summarizing, a large project is an umbrella for projects and sub-components:

• parallel projects - subprojects with limited dependency;
• control projects - for control and management of subprojects;
• infrastructure projects - they provide logistical support to the other subprojects;
• integration projects - projects starting after subproject have began. Their purpose is to integrate and combine the results of the different subprojects.

The size and complexity of a project are reflected in how projects are managed and the likelihood of their success. Often the likelihood and impact of risks are associated with project size. Why? Because large projects tend to use resources from multiple organizations.

INDUSTRIAL PROJECTS IN TRANSNATIONAL ENVIRONMENT

In developing new global product, many multinational companies are seeking mutual cooperation between their subsidiaries worldwide. Such transnational cooperation impose launching new transnational projects whose teams are geographically and culturally dispersed. These circumstances induce a high degree of complexity in project management, in particular regarding coordination of activities and communication within projects.

Aided by the unprecedented development of information technology (IT), multinationals have brought "closer" subsidiaries around the world in order to eliminate redundant activities. Apart from this, multinational companies have begun developing global products or product platforms in order to reduce costs on research and development of products, increasing production volume. Nowadays there are already relational complex models to optimize enterprise resources, as a strategy to bring forward the challenges of high costs for research, time for bringing them to market, increased demand on quality, environmental rules, globalization of markets and a high increasingly competition. Development of global products requires different knowledge, technologies, multiple capabilities and involve different categories of customers spread geographically around the world, with different cultures. (Liviero, Karminski, 2006; Mendez, 2003). Development of the automotive sector in Romania is a good example of the situation outlined above. For this, the objectives to be achieved, program and all other processes inherent in the project are required to be understood by all project members from different parts of the globe.

Given these circumstances, transnational context can add complexity to project management process. In what follows, I will present the main factors identified in the literature that could influence the results transational project teams:

• Linguistic diversity

Transnational project teams involve interactions between members of different teams and different languages, and without a common corporate language (usually English), communication between project team members is impossible. (Schweiger, Atamer, Calori, 2003). Although the internet age and knowledge of corporate globalization has become an imperative to become a member of a transnational team, low levels of English language knowledge still exist. Thus, linguistic diversity interferes with the project and an insufficient deepening and corporate language learning can lead to failure of execution of a large complex project of a transnational environment.

• Cultural diversity

There are authors in literature such as Chevrier, 2003, McDonough III, Kahan, Barczak, (2001) Schweiger, Atamer, Calori (2003), which argue that cultural diversity could be beneficial to global projects in the outcome of product development, global diversity representing a potential source of new ideas. On the other hand, the same authors argue that cultural diversity is causing ambiguity, confusion, making interaction between project team members more complex and creates barriers between project teams. So, the negative effects tend to prevail in the face of possible advantages mentioned above, using multicultural teams in developing global products. Therefore, although it is impossible to change cultural aspects, it is important to understand how cultural issues may influence the results of projects to know how to cope, minimizing or controlling adverse effects.

• Leadership

When we talk about leadership in the context of big projects in transnational environment are two important issues to be considered:

-project management leadership;

-corporate leadership.

Traditionally speaking, it is clear that the ability of the project manager is crucial and decisive for project success, but when we talk about the transnational projects, different cultures have different perceptions about effective leadership. Therefore, it is difficult to define and decide the ideal profile of project management leadership in a transnational context.

The second aspect to be considered for the study, is corporate leadership that creates the basis for the functioning of project organizations. Therefore, corporate management must be part of the management of transnational projects, defining strategies and priorities, participating in important decisions, resource allocation to different projects. In transnational context, projects deal with complex scenarios. For example, a product can be designed by the project head quarter together with the subsidiary in country A, then developed by subsidiary in country B and C, and then sold subsidiaries A, C, and D.

CONCLUSIONS

Contemporary large projects developed by various multinational companies in transnational environment determine a new project management approach through the complexity that they bring to our attention, and without proper instruments and methods in order to analyze and understand complex systems, these can become complicated. As shown, there are many discussions and numerous books and articles on complex projects

in recent years. Complexity is defined in a varied manner according to the area where it is found, being identified at least 31 definitions (Ghul and Khan, 2011), but there is not a consensus on a standard definition for a complex project. Rather, the analyzed authors suggest their own definitions, or try to explain projects through the theory of complexity, or both. But there is a common denominator in terms of complexity characteristics of projects, as follows:

• consists of several parts;
• existence of a series of connections between the parts;
• existence of dynamic interactions between parts;
• behavior results from these interactions and can not be explained as a simple sum of the parts (emergent behavior).

Analyzed authors agree that projects of any kind and at any scale share usually common characteristics, but particularly large projects in transnational environment involves partners from different organizations in different parts of the world requires a comprehensive approach because it involves multiple risks and uncertainties. Among the common characteristics of each project, regardless of shape and size, the analyzed authors encountered above were identified:

• projects are activities limited by time, resources and purpose, they differing from normal activities of an organization, which are generally permanent and repetitive;
• projects involve teams of people with different backgrounds and from different organizations;
• projects are often associated with changes in innovation and creating new products and services, methodologies, involving uncertainties and risks
• each project presents different degrees of complexity.

The out of this literature study represents an integration of different approaches concerning complexity under one umbrella to provide a common understanding of the evolution of this concept (Table no. 1).

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Tabel no. 1: Chronological evolution of different approaches to complexity

Authors	Study / Research	Novelty	Study motivation	Study methodology	Industrial sector	Complexity: definition / description
Turner & Cochrane (1993)	*"Goals and methods matrix: Coping with projects with ill defined goals and/or methods of achieviing them."*	New model	Evaluation of complexity projects	Theoretical study	General	Turner and Cochrane have developed an array goals/ methods in which projects were classified using two main parameters: how well defined are project goals and methods to achieve them.
Stacey (1996)	*„Stacey Agreement & Certainty Matrix"*	New model	Proper identification process where efficiency and effectiveness are maximized.	Theoretical study	General	Stacey analyzes the complexity in terms of two dimensions: -certainty of projects; -agreement of the stakeholders in projects. This model provides a method for the selection of appropriate management actions in a complex adaptive system, emphasizing the choice between approaches in management or leadership decisions.
Baccarini (1996)	*„The concept of project complexity"*	New model	Understanding complexity by studying various directions / components.	Theoretical study	The construction sector	Baccarini defines complexity of the projects as "... composed of several parts, such as tasks, specialists, and other components, which are in various degrees of networking..." He describes the complexity of the projects in terms of organizational and technological complexity.
Willams (1997, 1999)	*„The need for new paradigms for complex projects."*	Based on the study's Baccarini (1996) Turner and Cochrane (1993)	Understanding complexity by studying various directions / components.	Theoretical study	General	Williams shares the same vision with Bacarini regarding the complexity of the projects (which refers to the number and types of items, the differences between them, and the number and degree of differentiation in the relationships between them), adding additional dimension called uncertainty as basic dimension of complexity.
Hassan & Kahane (2005)	*"Managing Complex Projects: A New Model."*	New model	The process "U" as a methodology to address the challenges of complexity.	Theoretical study	General	Hassan and Kahane addresses the complexity as deeply rooted in the social environment. They distinguish complexity in three different ways: -dynamic complexity; -generative complexity; -social complexity.

Geraldi & Adlbrecht (2007)	*„On faith, fact and interaction in projects."*	Based on the study of Baccarini (1996); Williams (1999)	Understanding complexity by studying various directions / components.	Qualitative study	Industrial plant sector	A pragmatic approach to the complexity of projects is carried out by Gerald and Adlbrecht in 2007. The model developed by them has his theory as the basis Bacarini and Williams, but brings two new terms: complexity opportunities, circumstances and the interactions.
Reminghton & Pollack (2007)	*"Tools for Complex Projects"*	Extensive literature review and interviews with practitioners of project management	Understanding complexity through the study of different directions / parts and tools for management systems.	Theoretical study	General	Compared to the authors analyzed above, Remington and Pollack propose to study four types of project complexity: -structural complexity; -technical complexity; -directional complexity; -temporal complexity.
Girmscheid & Brockmann (2008)	*"The Inherent Complexity of Large Scale Engineering Projects, Project Perspectives"*	New model	Understanding complexity by studying various directions / components.	Theoretical study	General	Authors analyzed the inherent complexity of large-scale industrial projects (Large Scale Engineering Projects - LSEP) as representing the degree of multiplicity, interdependence and consequently impact decision making.
Maylor, Vidgen & Carver (2008)	*„Managerial complexity in project-based operations"*	Based on the study of Baccarini (1996); Williams (1999)	Understanding complexity by studying various directions/ components.	Qualitative Study (workshop with over 100 project managers)	General	The model proposed by the three authors is known as MODST, which stands at 5 dimensions or characteristics of complexity projects that managers must consider: mission, organization, distribution, stakeholders, project teams.
Haas (2009)	*"Managing complex projects"*	New model	To generate profiles of complexity projects.	Theoretical study	General	Haas chart is based on eight areas of uncertainty encountered in developing large complex projects: -cost/duration; -team composition and performance; -emergency/flexibility; -clarity of problems/solutions, - volatility; - political sensibility / multiple parties involved in the projects; - level of organization / business changes; -risk, external constraints, dependencies.
Bosch – Rekveldt (2010)	*„Grasping project complexity in large*	Extensive literature review and	Framework for understanding the	Theoretical study	General	Bosch - Rekveldt created a new framework for understanding the complexity of projects called TOE, the technical dimension

	engeneering projects."	interviews with practitioners of project management	complexity of projects called TOE.			(T) includes potential causes of complexity in terms of scope and content of the project, the size of the organization (O) includes potential causes of complexity in terms internal organization of the project and the external dimension (E) includes potential causes of complexity in terms of external environment problems.
Geraldi, Maylor, Williams (2011)	*"A systematic review of the complexities of projects"*	Based on the study's Geraldo and Albrecht (2007) Mayle, Vidgen and Carver (2008)	Framework "umbrella" including authors contributions until 2011.	Summary of academic literature that addressed the complexity of the projects over time	General	Authors have identified and regrouped complexity types, attributes and indicators around five major categories of projects complexity, as follows: - structural; - dynamic; - uncertainties; - temporal; - socio-political.
Gul şi Khan (2011)	*"Towards a comprehensive model of project complexity"*	Based on the study by Turner and Cochrane (1993) Williams (1999)	Model proposed by the two authors allow mainstreaming social projects as an important contributor to the complexity of the projects in a globalized world without trade and financial barriers.	Theoretical study	General	Authors argue that Williams's model is too simplistic, not only ignores the effects of social interactions but also their contribution to the complexity of the projects. Moreover, authors have extended the model of "uncertainty" proposed by Turner and Cochrane, adding to this uncertainty brought about by the external environment.
Institutul de Management al proiectelor (2013)	*"Project Management Body of Knowledge - P.M.I. - 2013".*	Literature study extensive	Understanding complexity through the study of different directions / parts	Theoretical study	General	PMBOK provides a summary of important characteristics of the projects which are in close correlation with the notion of complexity, as follows: -number of phases of a project; -the content of the draft management plan; -the level of applied control; -the level of detail for work packages; -the accuracy of cost estimates; -the need for formal and informal assessment of project performance; -the number of stakeholders in the project.
Pigagaite, Silva și Hussein (2013)	*"Sources of complexities in new product and*	Literature study extensive	Understanding complexity through the study of	Theoretical study	Development of new industrial products	Authors identified 5 categories of complexity sources: staff diversity, uncertainties, technological

	process development projects"		different directions / parts			novelties dependency and customer's interference in the development process of new products.
Zhu și Mostafavi (2014)	*"System-of-Systems Modeling of Performance in Complex Construction Projects: A Multi-Method Simulation Paradigm"*	New model	Techniques and means for creating an integrated management of complex engineering projects	Theoretical study	The construction sector	In their research, other systems within the system aim to create techniques and tools for integrated management of complex engineering projects. For developing the authors used two principles: - abstraction at the basic level; - multi-level aggregation.
Botchkarev şi Finningan (2015)	*"Complexity in the Context of Information Systems Project Management"*	Based on the study's Mostafavi and Zhu (2014)	Identifying individual attributes of complexity.	Theoretical study	I.T.	Based on the finding that complexity has become an inherent attribute of any project, the intention of the two authors was to define the complexity so as to facilitate construction of an early warning system to enable the project manager / project teams to focus on areas and critical aspects of projects in order to prevent risks and mitigate problems that are related to complexity.