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## Complexity in Project Management

J.R. San Cristóbal\*

*Project Management Research Group, University of Cantabria, C/German Gamazo, Santander 39004. Spain*

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### Abstract

Understanding complexity is of significance importance for project managers because of the differences associated with decision making and goal attainment that appear to be related to complex projects. As projects have become more and more complex there has been an increasing concern about the concept of project complexity as it influences upon the project management process. The importance of complexity to the project management process is widely acknowledged for several reasons. Complexity affects the modelling, evaluation, and control of projects and the objectives of time, cost, quality and safety. Complexity can also affect the selection of an appropriate project organization form and the project management arrangement including the expertise and experience requirements of project managers. In this paper the concept of project complexity is analysed and the main models of project complexity are presented. Our results evidence two aspects, the lack of consensus when defining project complexity and the fact that the focus of complexity models is basically on goals and methods, the level of agreement and certainty or the number of elements and their interdependency no taking into account other critical aspects of complexity.

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\* Corresponding author.

*E-mail address:* [jose.sancristobal@unican.es](mailto:jose.sancristobal@unican.es)

## 1. Introduction

An understanding of project complexity and how it might be managed is of significance importance for project managers because of the differences associated with decision making and goal attainment that appear to be related to complexity<sup>1,2</sup>. As projects have become more and more complex there has been an increasing concern about the concept of project complexity and the application of traditional tools and techniques developed for simple projects have been found to be inappropriate for complex projects<sup>1,3</sup>.

The importance of complexity to the project management process is widely acknowledged for several reasons<sup>4,11</sup>: (i) it helps determine planning, coordination and control requirements; (ii) it hinders the clear identification of goals and objectives of major projects; (iii) it can affect the selection of an appropriate project organization form and experience requirements of management personnel; (iv) it can be used as a criteria in the selection of a suitable project management arrangement; (v) it can affect different project outcomes (time, cost, quality, safety, etc.). In this paper the concept of project complexity is analysed and the main models of project complexity are presented. The paper is organized as follows. The next section shows the concept of project complexity. Section 3 presents the main models of project complexity in the literature and Section 4 provides the main conclusions and guidance for future research.

## 2. The concept of complexity

There is a lack of consensus on what complexity really is in project contexts<sup>12-15</sup>. Even, there does not seem to be a single definition of project complexity that can capture the whole concept. In fact, definitions of complexity continues to be ambiguous<sup>16-19</sup>. Complexity can be understood not only in different fields but has also different connotations within the same field<sup>20</sup>. Edmons<sup>21</sup> proposes a generic definition of what complexity is related to the way the project system is modelled

There exist many definitions of complexity. A very basic and simple definition of complexity starts by describing the number of different elements in a system alone as its complicity and the number of elements in a system and the possible relations among these elements as complexity<sup>2</sup>.

Within the Luhmannian system theory, complexity is the sum of the following components<sup>22</sup>: The differentiation of functions in a project between clients, contractors, subcontractors, suppliers, banks, etc., or the internal differentiation of the contractor's organization (degree of manifoldness); The dependencies between supersystems, systems, and the different subsystems or among the latter ones (interrelatedness); and the consequential impact or processes of a decision field. Baccarini<sup>1</sup> views complexity as consisting of many varied interrelated parts while Ward and Chapman<sup>23</sup> view the number of influencing factors and their interdependencies as constituents of complexity. Tatikonda and Rosenthal<sup>24</sup> view complexity as consisting of interdependencies among the product and process technologies, novelty and difficulty of goals. Vidal et al<sup>14</sup> claim that complexity can be viewed as a property of the system that makes it difficult to understand and Pitch et al<sup>25</sup> define complexity as information inadequacy when too many variables interact.

Some authors consider uncertainty as a component of complexity and vice versa. Williams<sup>26</sup> views the number of elements and their interrelationships as constituents of structural uncertainty which is proposed as an element of complexity. Shenhar<sup>27</sup> regards complexity and uncertainty as orthogonal to each other. Somner and Loch<sup>28</sup> treat complexity and unforeseeable uncertainty as separate constructs. Atkinson et al., (2006) consider complexity as an element of uncertainty while Geraldi and Adlbrecht<sup>29</sup> and Geraldi et al<sup>13</sup> support uncertainty as an element of complexity. Perminova et al<sup>30</sup> equate complexity to systematic uncertainty.

## 3. Complexity models

Gidado<sup>4</sup> determines four different sources of complexity: employed resources, environment, level of scientific and technological knowledge required, and number of different parts in the work flow (a large amount of required resources, a turbulent environment, working on the edge of technology and innumerable possible interactions are certainly identifiable for complex projects). This definition seems to be just related to task complexity and does not consider others possible layers of complexity such as social complexity (i.e., the numbers and diversity of actors communicating and working with each other); cultural complexity (it compresses the history, experience, and sense-

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