Journal of Cultural Heritage 16 (2015) 81–87

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en

Original article

Systematic approach for sustainable conservation

Daniela Dvornik Perhavec, Danijel Rebolj, Nataša Šuman*

University of Maribor, Faculty of Civil Engineering, Smetanova 17, 2000 Maribor, Slovenia

ARTICLE INFO

Article history:
Received 15 February 2013
Accepted 16 January 2014
Available online 17 February 2014

Keywords:
Cultural heritages
Conservation
General system theory
Managed knowledge

ABSTRACT

The conservation of cultural heritage and the renovation of other historical buildings requires a whole and interdisciplinary approach, cooperation between experts and the use of modern computer-based instruments, appliances and tools with a single goal – sustainable renovation. The sustainable approach also requires a high professional level of activity and time to study and do research on the buildings. The criteria for renovation are made-up of agreements and compromises between the interests of the local government and the common motives and interests of the individual owners and prospective investors. In order to achieve a sustainable renovation, certain supportive elements are needed such as financing, successful project management, and an adequate number of qualified craftsmen with special skills. This article tries to clarify what types of systems and subsystems need to be considered when renovating cultural heritages, when and why we come to deal with a probability – stochastic system, and what would be needed to successfully re-establish a determined system. By analysing the different methodologies within the framework of a complete renovation, we are developing a methodology for introducing the determined system for renovation projects and a model for analysis and decision-making during the preliminary design with the use of modern IT.

1. Research aims

This article hypothesises to what degree a project is a determined system that can be hierarchically broken into subsystems. We noticed that according to different definitions of a construction project as a system authors [1–5] rarely refer to a construction project as a whole system. As they are familiar with only certain specific phases of a project, the same authors only describe an individual phase as a system. Unlike projects for newly built structures, conservation projects connected with cultural heritage are not only more complex but are also more demanding. This is caused by – at the initial stage of a renovation project – a lack of knowledge about building materials, construction and the foundation, as well combining these individual parts into a unit called a building. Due to the many interconnections, it is difficult to find a system and set-up a mode that would describe a renovation project regarding cultural heritage, despite any in-depth research into it.

2. Introduction

Each project presents its own challenges regarding accurate cost, time projection, and control. Construction projects must address the topography and conditions of the project's site and the relationship of the project with the environment. A construction project may be phased to provide an opportunity for refining the project design from the initial phase. Most importantly of all is the fact that regulations require construction projects to hire a team of specialists from various construction-related disciplines. Construction projects involve many stakeholders with varying demands, such as taxpayers, regulatory agencies, governments, and environmental or community groups, that many other types of projects exclude.

Different authors of project management quote a similar classification of projects but not identical. According to several authors [1,4,6] construction projects can be described as non-routine, non-recurring, one-time venture's, and financial and technical implementation projects. They can be seen as a collection of tasks and activities [7] that must be completed before the end of the project. Each project has its own structure that divides the project into subprojects with partial targets. By following the description given in the Construction Extension to the PMBOK Guide [6], the authors show that construction projects inherently contain a high degree of risk regarding their projections of cost and time.

The article discusses renovation projects of historical buildings that represent construction projects and are closely connected with the humanities, arts and social sciences. Moreover, they are connected with the urban and spatial components of the project [8–10]. Systematical treatment of renovation projects leads to sustainable conservation. Hence, sustainable conservation includes concepts

* Corresponding author. Tel.: +00386 2 2294 355.
E-mail addresses: daniela.d-perhavec@um.si (D. Dvornik Perhavec), danijel.rebolj@um.si (D. Rebolj), natasa.suman@um.si (N. Šuman).

1296-2074/$ – see front matter © 2014 Elsevier Masson SAS. All rights reserved.
http://dx.doi.org/10.1016/j.culher.2014.01.004

of heritage value; of social, economic, environmental, scientific, technological effects; and of design and engineering decisions on physical sustainability. Further implications comprise our actions for preserving constructed heritage within the natural environment, as well as planning and managing interdisciplinary heritage projects.

In Chapter 3, we first explain the system's theory and its relationship to construction projects. Then, we describe the impact of the design phase through the construction phase and the causes of changes to the determined system. Then we discover out and analyse several methodologies for supporting and achieving a successful renovation. Then, after analysing four completed renovation projects in Maribor, we propose a new methodology that includes activities for systematic and sustainable renovation. At the end of Chapter 3, we prepare a model based on knowledge acquired using information technology.

3. Project and system theory

According to the authors [1,4–6], a building includes construction, craft, and installation work. Fitting equipment and furniture is also required on occasions. The construction phase can be divided into work related to the preparation of construction and work directly on building the structure itself.

Most construction projects can be viewed as five phases, although there are sometimes four. These phases [6] are:

- conceptual phase;
- planning (and development) or preliminary design phase;
- detail design phase;
- construction phase;
- start up and turnover.

Processes overlap throughout the entire project or project phases. The processes are described using the following terms [6]:

- inputs (planning outputs, historical information, organizational policies, constraints, assumptions, etc.);
- tools and techniques (project planning methodology, the skills and knowledge of the subcontractors, project management information system, etc.);
- output (project plan, documents, supporting details, etc.).

Ludwig von Bertalanffy, used the phrase "general systems theory" [11] around 1950. The general system theory, for him, was concerned with developing a systematic framework for describing general relationships within the natural and human-made world. Concepts and hypotheses formulated in one area seldom carry over to another, where they could lead to significant forward progress. It would have operational value and would reflect a new, powerful view of the world, as it has synergistic properties.

Systems are composed of components (elements or parts of a system), attributes (properties as characteristics, configuration, qualities, etc.) and relationships among these elements. Fig. 1 shows the relationship between the inputs and outputs of a system: inputs (x), tools and techniques (f [x]) and outputs (y).

The construction project as a system, has been theoretically dealt with by different authors. Dickerman [3] noted that many people use the term "system" without fully understanding it's meaning. He suggests that during communications on the subject, special effort should be made to ensure that the context in which the term is being used is clearly understood. Rothenstein [2] stated that a system is the complete integration of all subsystems (structural, mechanical, walls, etc.) assemblies, components and parts into one overall system making full use of industrialised

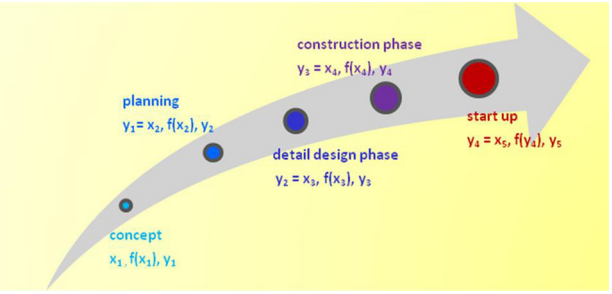

Fig. 1. Relationship among inputs and outputs of construction projects as a system.

production, transportation, and assembly. He designated "subsystems" as describing all other combinations of materials or structural concepts. Loncaric [1] showed that the execution of a construction project can be defined as a dynamic, complex, open, organisational or stochastic system. Kast and Rosenzweig [4] saw the system as a unique wholly-created two or more independent parts, limited by the surrounding system. Furthermore, Zaja [12] defined a system as a coherent whole, where each consisting part of the whole is directed to fulfill a common goal. Meredith [5] describes a system as a set of elements connected with a certain interaction or dependency that reacts, together with initiatives and demands from the environment, and fulfills a certain purpose or performs a certain function.

3.1. From preliminary design to the construction phase

While many authors focus on "sub-phases" directly connected to the building of a structure, the process involved in the construction phase often neglects the preparation phases required before beginning the work. Irregularities or deficiencies that occur during the preparation process of a project often directly impact on the construction itself. What the scope of this impact is depends on the approach of the contractual organisation, the organisation within the construction companies and on cooperation between the customer (or architects) and the contractors.

The conceptual phase has a significant effect on the construction phase, especially on the cultural heritage conservation projects. The building contractor is able to do the job well and professionally only when the previous phases have been well prepared. If the conceptual phase neglects any necessary activities, the contractor will have to deal with them later. Each change in the project represents a disruption that has to be dealt with quickly and with as little cost as possible. The costs and efforts for the implementation of changes within the project are lowest during the conceptual and design phase, whilst they are considerable higher during the construction phase.

If a project has well-defined objectives that are based on strategies that will ensure high quality construction work, it can be considered as a determined system. When there has been no detailed analysis of an existing situation, renovation the project can be described using probability systems [13,14] and there are generally two reasons why a system behaves stochastically:

- a determined system is subjected to external influences that are stochastic in character;
- the internal mechanisms of the system change due to unknown reasons, although they are assumed to be stochastic.

This description shows that a determined system is subjected to the effects of a stochastic nature (unknown external effects). Hereby the system changes from a determined system to an undetermined system during the conceptual phase. This latter leads to