



# Value Triangles in the Management of Building Projects

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## Abstract

The purpose of this paper is to investigate value triangles and their implementation in the management of building projects. The paper is based on results from a research project on space strategies and building values, which included a major case study of the development of facilities for Danish Broadcasting Corporation (DR) over time. The conventional iron triangle of quality, cost and schedule for project management is the theoretical starting point, but this is seen as mainly being related to process integrity in the construction stage. It is supplemented by a similar value triangle of cultural value, use value and quality of realization for product integrity, mainly for the design stage. Based on this framework an evaluation is made of the value management in six of DR's building projects from the first around 1930 to the most recent – the new headquarters DR Byen finalised in 2009. The conclusion is that DR's buildings have a strong focus on value and fulfilment of intentions. This is not surprising as DR is a public service broadcasting corporation. This means that the buildings on one side have to be high-tech production facilities and on the other side shall represent a cultural institution of national importance. The study indicates that the value triangles provide a useful framework to evaluate project management and discuss the characteristics of building projects. All together project management aims at reaching the project goals and optimizing performance by developing and maintaining project integrity with the right balance between value management and resource management throughout the project.

**Keywords:** Value triangle, project management, building project, product integrity, process integrity

## 1. Introduction

The focus of this paper is the implementation of value triangles in the management of building projects. The aim is to develop a framework for characterizing and evaluating the project management of different building projects and test the framework on a number of buildings from different periods. The paper is mostly theoretical but also presents the results from a case study, where the theoretical framework has been implemented and tested.

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The conventional iron triangle or value triangle of quality, cost and schedule for project management is the starting point, but this is seen as mainly being related to process integrity in the construction stage. It is supplemented by a similar value triangle of cultural value, use value and quality of realisation for product integrity, mainly for the design stage. Based on this framework an evaluation is made of the value management in six of the building projects of Danish Broadcasting Corporation (DR) from the first around 1930 to the most recent – the new headquarters DR Byen finalised in 2009.

The research was part of a project on space strategies and building values, which involved a major case study of the development of facilities for DR. The paper starts with a description of research method. The theoretical part includes an introduction and discussion of the conventional value triangle and a framework with supplementary value triangles for product integrity and process integrity is developed. The empirical part presents the results of the evaluation of the six buildings. Finally the results are discussed and conclusions are drawn.

The research aims to contribute to the development of a theoretical and empirical understanding of the management of building projects and the use of the concept of value in this context.

## **2. Research Methodology**

The theoretical part is based on a literature study and framework development in relation to project management both in general and in relation to building projects. The empirical case study is based on literature studies, archive research and an interview survey. The empirical literature studies have mostly concerned publications related to DR's history from 1925 and onwards. The archive research has supplemented the empirical literature studies and has included studies of archives at DR's internal library and archive as well as archives on some of DR's major building projects at the Danish National Archive (Rigsarkivet). The interview survey has involved 12 interviews with former managers in DR and former consultants for DR.

The research is based on a huge amount of empirical material about the case study (Jensen, 2006 and 2007). This paper only includes a brief summary of the results of the evaluation of six building projects from different time periods.

## **3. Theory on Value Triangles in Project Management**

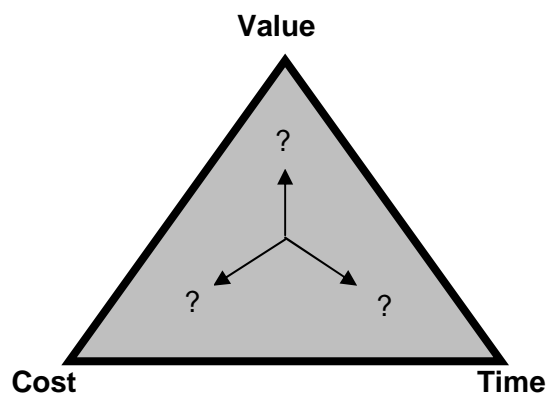
### **3.1 The concept of value triangles**

In the literature on project management it is common to see the objective as optimizing the outcome in relation to cost and time. The relationship between these three factors is sometimes described as the iron triangle (Atkinson, 1999), the project management triangle (Wikipedia, 2012), the triple constraints or the value equation (Verzuh, 2003). The outcome is described in terms like scope (Wikipedia, 2012), quality (Atkinson, 1999), benefit (Verzuh, 2003), and function, specification and performance (Engwall, 1995).

In the following the term “value” will be used for the outcome and the term “value triangle” for the relationships. This term is preferred because “value is the only fundamental metric which makes a positive contribution to all the other bottom-line metrics” (Cook, 1997). The term “value” has been used for a long time in industrial management as “Value Management” and “Value Engineering”, but these terms have also become common in Quantity Surveying (Kelly and Male, 1993). Furthermore, the term “value” has in general been used increasingly in construction management research over the last decade; see for instance Spencer and Winch (2002), McMillan (2006) and Thyssen et al. (2009).

A project that keeps within budget and schedule and results in a product of high value is typically regarded as a success. The challenge in the planning of a project is to create the equilibrium between the three factors. The value of the product depends on how much time and money one is willing to invest. When this balance has been fixed, a change in one factor will influence the other two factors.

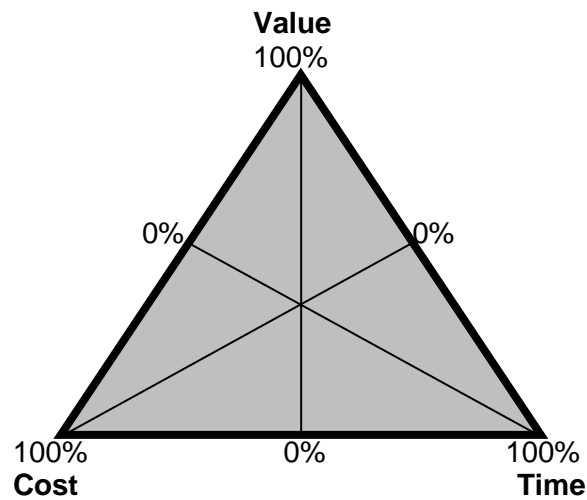
According to Engwall (1995) the relationship between the three factors can be illustrated as an equilateral triangle stretched between value, cost and schedule in each corner as shown in Figure 1.



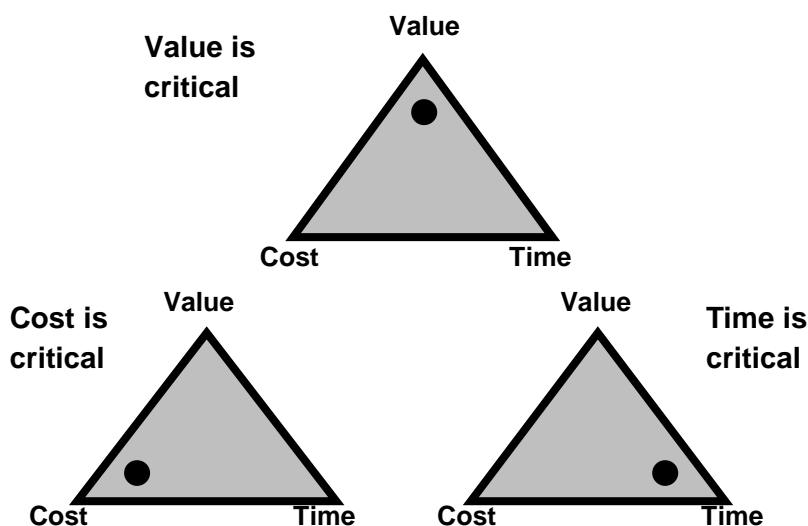
**Figure 1: The conventional value triangle (Briner et al, 1991 and Engwall, 1995)**

The triangle could be seen as having three axes, which can be used to indicate the priority of each factor. This is illustrated in Figure 2. The sum of the priorities necessarily has to be 100%. If all factors are given equal priority, then the centre of gravity will be one third on each axis, i.e. a priority of each by 33.3%.

Different projects will have different centres of gravity in the triangle. This is illustrated in Figure 3 with the three extreme situations, where value, cost or time is the dominant factor, respectively. Concert halls and nuclear power plants can be mentioned as examples of projects, where value is the critical factor, because the functional aspects are dominant. Production buildings and social housing projects are often very cost critical, while the schedule is extremely critical for facilities for sports events like the Olympic Games with a clear deadline.



**Figure 2: The value triangle with axes of priority**



**Figure 3: Value triangles for projects with extremely different priorities**

The total value of a project consists of the resources (cost and time), that are used in the project, and the value that is created as a result of a successful project. When the project goal is set one must define the value that the project should result in and the resources available for the project. An implicit part of the goal normally is an expectation that the value should be optimized in relations to the use of resources and therefore the value creation should be maximized. Thus, a primary task for the project management is to secure an effective value management and an efficient resource management.

### 3.2 Implementation and innovation projects

Verzuh (2003) emphasizes, that the priority between the three factors in the value triangle should take place in the project definition phase, before the decision to start a project.

According to this view the priority should not be made by the project organisation but by the client or sponsor, who make the decision to start the project. Engwall (2002) distinguish between implementation projects and innovation projects as described in Table 1.

**Table 1: Implementation and innovation projects (Engwall, 2002 – translated)**

	Implementation project	Innovation project
Pre-knowledge	Complete	Incomplete
Project goal	Exogenous to the project work	Endogenous to the project work
Knowledge development	During preparation	During preparation and during the project development
Result	Final product	Final product and knowledge about the project goal and the process to reach it
Rationality	Efficient delivery of the result	The right knowledge about the result

In implementation projects the project goal is exogenous to the project organisation and this is equivalent to the view of Verzuh (2003) with project goals defined by the sponsor. In contrast, the definition of the project goal is endogenous for innovation project, i.e. it is a part of the work in the project organisation to define the project goal and set the priorities.

Building projects can be either an implementation or an innovation project or a combination of both. A small, standardized building project can be regarded as an implementation project, while large and complex building projects can be seen as innovation projects. That is particularly the case in the early stages with briefing and conceptual design. Construction based on a detailed design can contrarily be regarded as an implementation project.

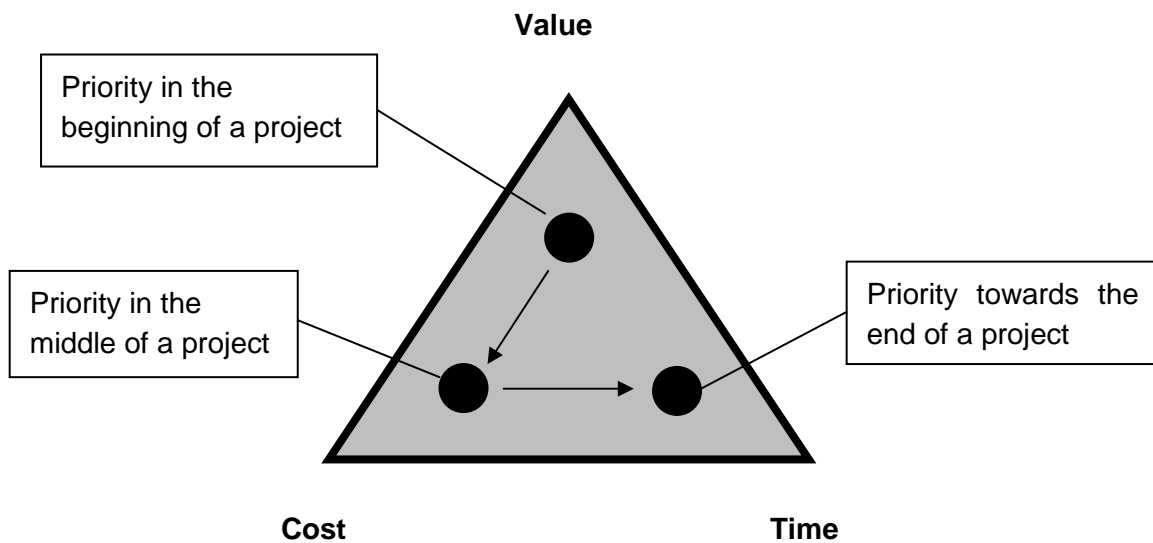
### 3.3 Changes in priorities

During a project the focus and therefore also the priorities between the three factors in the value triangle will often change over time. In the beginning the definition and fulfilment of the value will be the primary focus area. As the project develops the budgetary strains will become more present and this will change the focus towards keeping the budget and perhaps make savings to avoid overrun. Towards the end the deadline comes closer and keeping the schedule becomes the main priority. This typical development in the priority is illustrated in Figure 4.

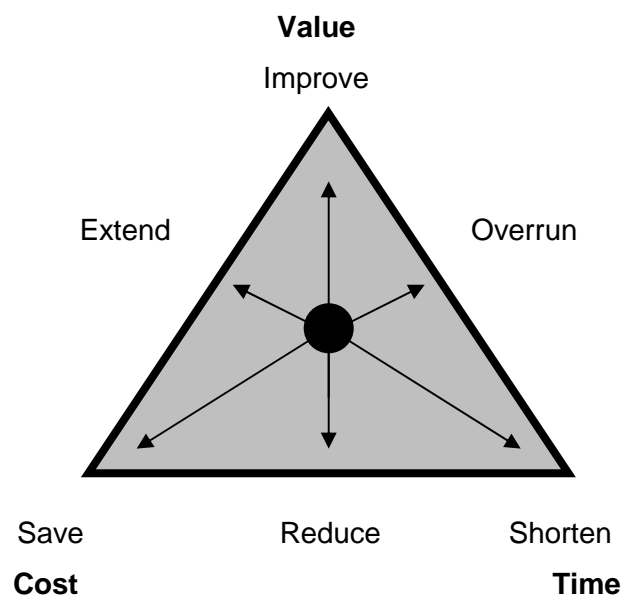
When the priority between the three factors in the value triangle has been made, it can be useful to change the axes to have the starting point in the centre of the triangle as shown in Figure 5. By this illustration it becomes clearer, how changes in the priority to the benefit of one factor will influence one or both of the other factors negatively.

Some of these relationships can be problematic. By extending the schedule it might be possible to improve the value – particularly if the project is delayed - but it is doubtful whether it gives possibilities to save cost. For building projects the cost of running the building site will for instance usually increase if the schedule is extended. Contrarily, it often

increases cost if the schedule is forced to be shortened. Therefore, the value triangle should not be regarded as an expression of some kind of absolute law, but only as a general illustration of principles for the relationships and priorities between the three factors.



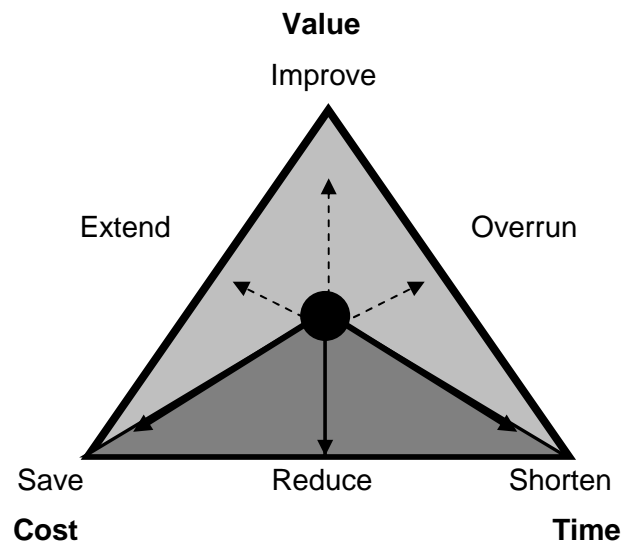
**Figure 4: Typical development in the priorities in a project over time**



**Figure 5: The value triangle with priority fixed in the centre**

### 3.4 Example of DR Byen

The use of the value triangle can be illustrated by the example of DR Byen. When the project was started in 1999 it was decided by DR's board, that it should be built within a budget of maximum € 400 million (DKK 3.0 billion) in the price level of 1999. A deadline for the project was stipulated as well. With these preconditions two of the three factors in the value triangle were fixed in one direction as shown in Figure 6.



**Figure 6: The value triangle for DR Byen**

The room for changing priorities during the project is reduced to the third part of the triangle marked by the dark grey colour. This means that there in principle only are the possibilities to reduce value, save cost and/or to shorten the schedule. A building project like DR Byen is very much an innovation project. Even though the budget and deadline was defined exogenously by DR's board, the value definition was at that stage only defined rather vaguely, and an important part of the project was to define the value more specifically and develop knowledge about the project.

One of the great challenges in the project management is that most external parties involved in the project has an economical interest in increasing value and thereby the cost of the part of the project, that they are involved with – even though that might be on the expense of the total budget or other parts of the project. Therefore, it is a crucial part of the management task to continuously prioritize the solutions in each of the different parts of the project and make sure that they stay within budget.

Fixing the budget and the deadline can be seen as a strait-jacket for the project management, but it can also have the advantage that it gives a clear objective and thereby a clear focus for the management – to optimize value within a set budget and deadline. It can be regarded as contradictory to define clear objectives for cost and time without a specific definition of the value. On the other hand, the typical development of building projects is suitable for a gradual detailing of the specification of the value objectives.

For the project management it can be an advantage to have a well defined budget and deadline. It increases the legitimacy, when a request to increase the value is refused. If it was possible to increase the budget or the value, the project management may have to accept to use time and energy to investigate various suggestions to increase the value and prepare decisions proposals to change the project, which can disturb the smooth running of the project. Therefore, it should never be too easy to change the project goals and objectives – and it should be more difficult the later in the project period it occurs.



It is of course a problem, if the cost and time limitations do not allow the value objectives to be fulfilled in spite of all possibilities for adjustments are made. In such a case the objectives for the three factors in the value triangle have been defined unrealistically without the necessary balance and they will have to be redefined. That is what happened in DR Byen and it meant that the budget had to be increased and the deadline postponed.

### 3.5 Product and process integrity

The English construction management researcher Graham Winch (2010) has by inspiration from the product development in the car industry created a model for product integrity or the quality of intention as shown in Figure 7. The quality of conception expresses the symbolic aspects in terms of elegance of form, spatial articulation and contribution to the urban culture. The quality of specification expresses the functional aspects in terms of the fit and finish desired, and the fitness for purpose of the completed facility. The quality of realisation expresses the resource and process aspects in terms of budget, schedule and the service delivery experience.

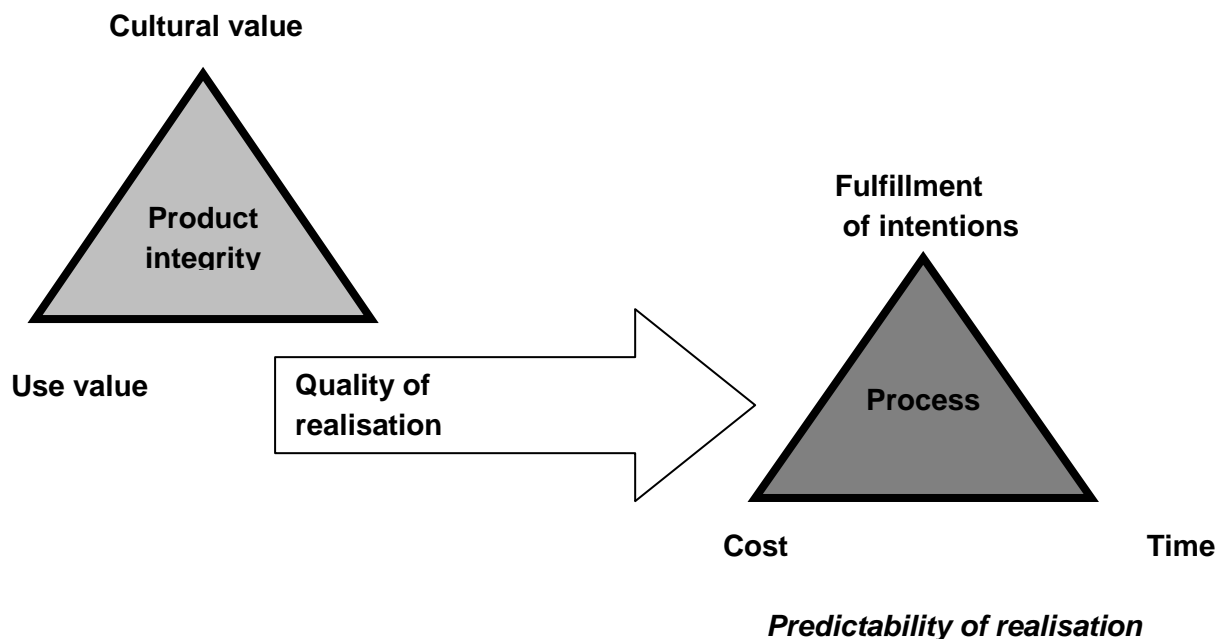


**Figure 7: Model for product integrity – quality of intention (Winch, 2010)**

Winch connects the model for product integrity with a model for process integrity, which is near enough identical with the value triangle presented earlier. The product integrity concerns an appropriate intention while the process integrity concerns a predictable realisation. This is shown in Figure 8. The terms “Quality of conception” and “Quality of specification” has been replaced by “Cultural value” and “Use value” in accordance with the arguments explained in section 3.1 about value as focus of this research.

According to the models for product and process integrity there are two main factors in the value management: Cultural value and use value. Similarly, there are two main factors in the resource management: Cost and time. Value creation in project management includes both value management and resource management.

### *Appropriate intention*



**Figure 8: Models for product integrity and process integrity (based on Winch, 2010)**

## 4. Empirical Results

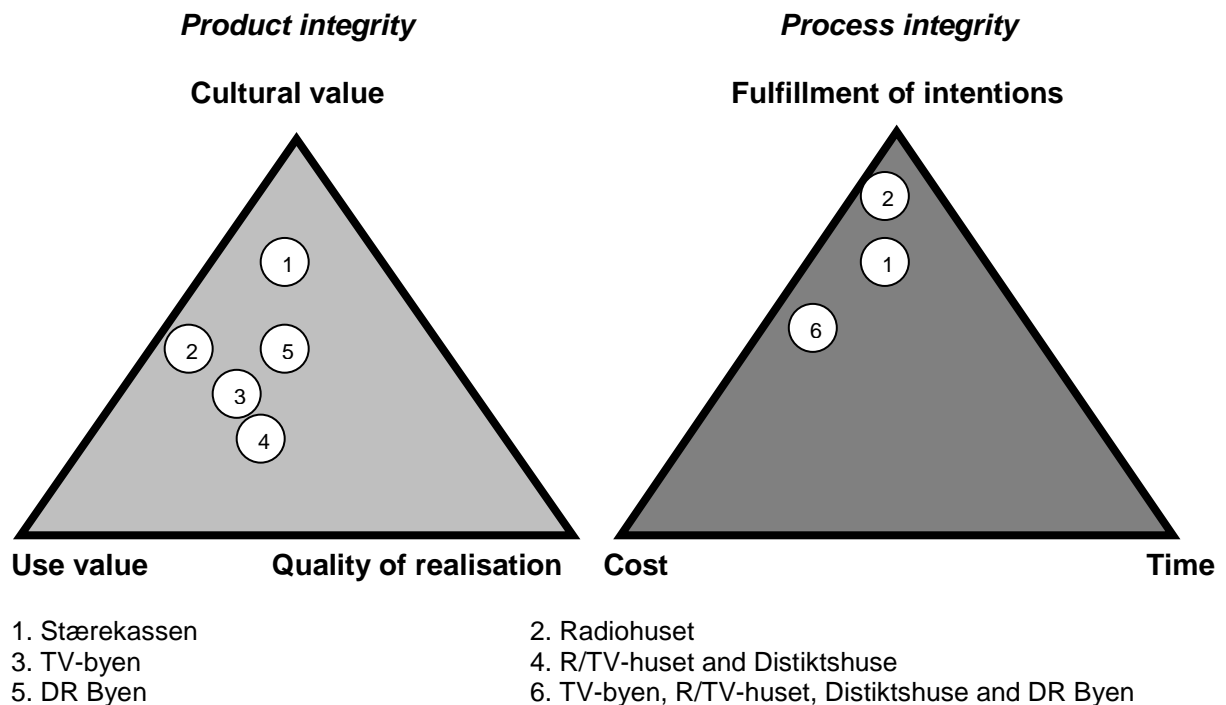
The six building projects that have been investigated and evaluated are presented in Table 2. They constitute the most important building projects undertaken by DR since its start in 1925 and differ very much in size and the time they were built.

**Table 2: The buildings included in the case study**

Estate/building	Locality	Period of DR's occupation	Area
Stærekassen (Nickname: Birds nest)	Copenhagen (with the Royal Theatre)	1931-1941	6.000 m <sup>2</sup>
Radiohuset (Radio House)	Frederiksberg (near Copenhagen city)	1941-2007	30.000 m <sup>2</sup>
TV-byen (TV town)	Gladsaxe (North of Copenhagen)	1964-2006	100.000 m <sup>2</sup>
R/TV-huset (Province radio/TV-centre)	Århus (in Jutland)	1973-	28.000 m <sup>2</sup>
Distriktshuse (Regional radio centers)	Odense, Vejle, Ålborg (3 province towns)	1983-	Each 2.600 m <sup>2</sup>
DR Byen (DR town)	Copenhagen (new development - Ørestad)	2006-	130.000 m <sup>2</sup>

The result of the evaluation of the six building projects in relation to the models for product and process integrity is shown in Figure 9. The oldest building – Stærekassen – is the most extreme with a very dominating focus on cultural value. The reason for this was, that the building was adjacent to the Royal Theatre and mainly built to provide an extra theatre hall

with the remaining space meant to be used by DR. However, the building was not suitable for radio production – for instance due to bad sound insulation between the theatre hall and the radio studios. The project was a big scandal at the time and the planning of Radiohuset started only a few years after Stærekassen was occupied.



**Figure 9: Evaluation of DR's buildings in relation to product and process integrity**

Radiohuset from around World War II had a very strong focus on both cultural and use value and had the most dominant focus in the fulfilment of intentions. It has for 65 years served as DR's main radio centre and concert hall and is now a preserved building as one of prominent examples of modernist architecture in Denmark and it is occupied by the Danish Music Academy. TV-byen from the 1960's and 1970's had stronger focus on use value and the quality of realisation – particularly in relation to cost.

The buildings R/TV-huset and Distriktshuse from the 1970's and 1980's had the least focus on cultural value and most focus on the quality of realisation. Among the reasons are that they were built after DR had for the first time established an internal building client function and the buildings were not headquarters. The new headquarters DR Byen is seen as having the most equal balance between the factors in relation to product integrity, while the process integrity is evaluated to be the same for all the buildings except the two oldest with a stronger focus on the fulfilment of intentions.

## 5. Conclusion

The conventional value triangle of project management should not be regarded as an expression of some kind of absolute law, but only as a general illustration of principles for the relationships and priorities between the three factors of value, cost and time. Winch (2010) provides a more differentiated picture by substituting the conventional value triangle

by a model with a triangle for product integrity and a triangle for process integrity. With this model the possibilities to discuss the value of a project is improved by introducing the distinction between the quality of conception and quality of specification - or cultural value and use value. Thereby it provides a more realistic view on the tasks and challenges of project management.

Project management involves the two interrelated tasks of value management and resource management. Value management aims at effectiveness in maximizing the value output of the project within the resource constraints by defining appropriate intentions and maintaining product integrity with the right balance between cultural value, use value and the quality of realisation throughout the project. Resource management aims at efficiency by minimizing the resource input into the project by developing a predictable realisation and maintaining process integrity with the right balance between fulfilments of intentions, cost and time throughout the project. All together project management aims at reaching the project goals and optimizing performance by developing and maintaining project integrity with the right balance between value management and resource management throughout the project.

The framework with models of product and process integrity has been implemented in an evaluation of six of DR's buildings. The general picture is that DR's buildings have a strong focus on value and fulfilment of intentions. This is not surprising as DR is a public service broadcasting corporation. This means that the buildings on one side have to be high-tech production facilities and on the other side shall represent a cultural institution of national importance. The high priority of value and fulfilment of intentions was particular significant in the two oldest buildings which included a theatre hall and a concert hall, respectively. The recent development, DR Byen, also includes a concert hall and even though DR Byen is evaluated as having fairly well balanced product integrity, the development of the project has shown that the ambitions of DR's building committee in relation to the architectural expression of the concert hall increased over time.

The study indicates that the value triangles provide a useful framework to evaluate the project management and discuss the characteristics of building projects. It is a tool that can help to give a better understanding of the differences between different projects and can be used to identify the particular challenges for the project management in a specific project.

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