THE INNOVATION PROCESS FOR PERSONAL RAPID TRANSIT IN EINDHOVEN

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Abstract

The innovation process in public transport is slow and nearly uncontrollable. This has been demonstrated in a project in Eindhoven. In this city a pilot was prepared to demonstrate the potential of Personal Rapid Transit. The pilot was a part of an innovation process that had to lead to a more sustainable urban transport system. The guidelines of the bureau DTO (Sustainable Technological Development) were followed to guarantee the long term feasibility and effectivity of the process. Other checklists were applied too in order to realize a certain and supported innovation process. However, a change of policy and key persons were the main causes of the failure of the project. The initial support faded away. The whole process was further slowed down by strict regulations for tendering, by which a loss of knowledge, experience and progress speed was stimulated. An analysis is made of different risk factors is made and some conclusions are given to have more chances for success in future similar innovation projects. The checklists that are applied provide a tool to make an *ex ante* analyis of the feasibility of an innovation project and give guidance to create optimal conditions for success.

Keywords: Innovation process in public transport; Eindhoven; Personal rapid transit
Topic Area: H10 Urban Transport Policy

1 Introduction

1.1 Personal rapid transit and EDICT

Accessibility of cities is a long lasting problem that existed in the past – even in antique cities as Rome – and probably will continue to exist in the future. The increasing size of cities and the conflict between demand of space for transport infrastructure, buildings and public purposes like parks exist in every city. The existing transport systems have their limitations and it is believed that new technology is necessary to solve the accessibility problem in a sustainable way.

Big concentrated transport flows in cities can be served by existing technologies like busses, light rail and underground. The access time to such concentrated services is relatively long, which makes these kinds of public transport only competing with the car for long distance trips or fro situations that origins or destinations of trips are concentrated in time and space.

A contribution to the solution of the accessibility problem can be found in automated individual transport. Personal Rapid Transit seems to be a very promising technology (Lowson 2003) . It is a kind of automated, driverless taxi with a dedicated infrastructure. The vehicles are intended for use by 1 to 6 persons, have electric propulsion, and are easily accessible also for disabled people. Stations are distributed along the line on a track parallel to the main track, so that stopping vehicles do not interfere with the main stream. Even with a moderate maximum speed, the average travel speed is higher that most forms of collective public transport using surface roads.

In The Netherlands several attempt have been made over many years to find innovative ways to improve urban accessibility using new transport modes like PRT. Nearly all attempts ended in reports without any change in reality (van Zuylen et al. 2001). The reasons for these failures are more institutional and political barriers than technological problems.

A project has been launched in 1997 to try to investigate the innovation process and to clarify the barriers that occur. At the same time the project had the goal to realize an innovation process that would lead to a more sustainable accessibility of cities.

1.2 The aim of this paper

For the successful introduction of innovative transport systems, it is vital to learn how we can manage these processes as effectively as possible and who is to play a role in them, This paper presents the evaluation of case study of an innovative process for the implementation of PRT in the city of Eindhoven.

Chapter 2 contains a description of the general characteristics of system innovation processes. Chapter 3 provides a description of the history of the Eindhoven case, structured according to the described characteristics in Chapter 2. Chapter 4 follows with a process-based analysis and an exploration of the institutional factors that played a role in the process. Chapter 5 describes the consequences of the completed process for EDICT and draws conclusions concerning the learning experiences and the mistakes that were made.

2 Innovation in public transport

The introduction of personal rapid transit (PRT) should be seen as a process of system innovation characterised by the introduction of a new element to the existing transport system. The characteristics of PRT differ significantly from those of the present modes like car, bicycle, bus, light rail, train and metro. PRT will have to prove its feasibility in technical, operational and economic sense and show its potential with regard to the present transport system in which the car has the leading role. Furthermore, PRT has to show that it can be integrated in the present transport system as a part of a trip chain. The specific niche where PRT fits in has to be identified. The introduction of PRT requires big changes: it is a new concept which makes a new organisation necessary and PRT also requires a dedicated infrastructure.

To enable this kind of innovative process to run successfully, all people involved have to pull together, entailing all manner of risks. The innovative process not only involves technology, it also has structural and cultural aspects. The *cultural aspects* include public acceptance, for example. The *structural aspects* include restrictive legislation or a lack of standardisation; spatial incorporation is also structural in nature. Examples of the *technical aspects* are the headway between the vehicles, control system.

Many stakeholders have interests in an implementation of PRT and will be involved in the innovative process. Generally speaking, they can be categorised as government, end-users, trade and industry, and technical development and research.

The *government* administers the public space and plays an important role in the articulation of the demands for the transport system, the spatial incorporation and construction of the system, balancing the interests of all stakeholders, the long term ambitions, the long period for return of investment and the considerable risks. The government is also responsible for the public transport system.

End users are firstly consumers, who actually use the transport system. The next group are the enterprises, which gain from the accessibility the system provides and are, therefore, also a system consumer. Both groups are sometimes directly involved in the

innovative process, but are often represented by the government, consumer organisations and chambers of commerce.

Trade and industry play a key role in the production, implementation, operation and management of the transport system. Sometimes, new alliances have to be forged to give shape to these aspects of innovation.

The final group of stakeholders is *technical development and research*, including laboratories, knowledge institutes and consultants. They can play a key role in problem definition and vision development, as well as in planning. Also for development and research organisations exist in many countries to coordinate R&D. Such an organisation can give a direction to the development of PRT if the organisation chooses this as a focus of interest.

The necessary interaction between the various players differs from phase to phase in the innovation process. Pioneering can also differ from phase to phase. The innovation process goes through the following phases (van Zuylen et al, 2001)

- Invention
- Test
- First application
- Market introduction
- Maturity
- Decline
- Replacement

In the case of the PRT system, the development is just in the phase where the experimental system components are ready to be implemented in practice, between 2 and 3. Without a strong government support, the growth of such a system is very uncertain or even impossible. A push from a government or provincial or local authority can help the innovation to come into life. This is the case in the Eindhoven project (van Zuylen et al, 2001).

Policy driven innovation processes have been successful in the past only for systems which were completely within the domain of one authority. Such innovation processes are much more complicated if many stakeholders are involved and when the innovation process has a long term for realization. Since a long term and policy driven innovation process with many stakeholders is rather uncommon, guidelines have been developed by DTO, a Dutch organisation for Sustainable Technological Development. They designed an innovation process that consists of the following steps (van Zuylen et al, 2002)

- Research Phase
- Problem definition and knowledge acquisition,
- Development of a vision for the future,
- Back casting,
- Definition of a first step in the innovation process,
- Policy Process
- Choosing a pilot location
- Pilot development
- Implementation
- Assessment and definition of the next phase
- Execution of the next phase

The innovation process has to be aimed at sustainable technological innovations suited for the long-term future. It is impossible to make a ‘blue print planning’ of the technology and the innovation process. It is important to have a clear picture of where the innovation has to lead to in terms of its functionality and the properties it should have. This is done by

the development of a *vision for the future* in the Research phase. In some projects this was done by asking some experts to write an essay about their vision on desired developments. In workshops with stakeholders the essays are used as a first step in the development of a vision that is shared by all people involved.

The next step is to look for a possible path that could lead from the present situation to a future in which the vision has become true. This is called *back casting* as complementary to forecasting: looking forwards to the future starting from the present situation. In back casting the future is normative and the development path is not predicted, but chosen. Back casting means that one reasons starting from the desired future (the vision), a path is invented that connects that future with the present situation.

The back casting phase leads to a definition of first steps. Often these steps have the character of an experiment or pilot, aimed at getting more knowledge about the feasibility and possible further steps.

The next phases must lead to the preparation and implementation of this kind of experiment or pilot. After this experiment, the next phase in the innovation process can be defined and executed. In every step, the vision for the future is leading. After each step the vision has to be revised, the path has to be modified according to the experience and the next step has to be determined.

3 History of the process

This chapter describes the history of the Eindhoven case, structured according to the DTO process explained above. Although the research phase and the political process had been completed in the Eindhoven case, the project stranded before pilot development could get underway.

3.1 The research phase

3.1.1 Introduction

In 1997 the Transport Research Centre AVV of the Dutch Ministry of Transport started a research project to search for a *Transport System of the Future*. One of the objectives of the project was to set up an innovation process that would realise a new transport system in the medium long-term future. The requirements of the initial research project were that

- the transport system would have to solve a part of the present and future transport problems,
- would be sustainable and
- would be suited for the long-term future, e.g. the next 40 years.

There were at least two objectives important apart from the actual goal to define a transport system for the future. These objectives were:

- to learn how to deal with innovation processes, to share that knowledge with the other people in the Transport Research Centre
- to develop and apply a methodology for the realization of sustainable innovations.

That means that the process followed and the methodology applied in this project were also important.

Rather early in the process the choice was made to focus the project on transport in urban areas, where the conflict in space usage is quite urgent.

3.1.2 Stakeholders

Interaction and public participation are a major feature of Dutch planning culture. Acceptance of new plans is strongly related to the degree of involvement and participation in their formation (van Zuylen 1998). Also in Transport System of the Future, a group of

relevant actors became involved in the project. Several workshops have been organized in which possible actors participated

Several *cities* were interested in the implementation of a new transport system. However, many of them had already executed several studies on the possibilities of new transport systems. Most of the cities have not made an attempt to start a practical pilot. Producing plans appears to be easier than executing them. One of the reasons has to do with the fact that the responsible authority of a city was chosen for a term of four years, sufficient to have a study done and to show the potential of new transport systems, but insufficient to realize a pilot and to get the profits in terms of a more satisfactory accessibility of the town. In general municipalities do not consider innovation of transport system to be a task for them. Most cities do not have the necessary expertise and resources to realize an innovation process without external help. Still the co-operation of cities is indispensable.

Most cities that were invited to co-operate were quite passive, the support of the responsible authority was small, apparently because the feasibility within a relevant term was too low. Only a few cities working with a long-term policy for improvement of the accessibility stayed in the process and remained active. The rather passive role of cities has also its cause in the limited time resources of their employees, people who have to manage a lot of other short term activities which have a higher priority than long term issues.

The representatives of the *Ministry of Transport* were interested in the project, but they did no want to commit themselves. The reason was the fact that cities are responsible for their accessibility and provinces and cities are together responsible for public transport. The central government could only take a role in the support of further research and development, if asked by the organizations that had the need for the new transport system. The central government did not want to take the role to help inexperienced cities to start an effective innovation process.

Netherlands cities and provinces have a cooperation platform in which also knowledge transfer is organised. This organisation, called VERDI, has limited resources and time budget of its employees. These resources are used for activities defined within the organisation, such that suggestions coming from outside could not easily be integrated in the activity schedule and get a low priority. That was the reason that VERDI did not play a role in the PRT project.

Consultants initially played a minor role in the process. They were hired to bring in specific knowledge and executing certain tasks. Their experience and knowledge of public transport and innovation processes is quite important and the activities of some consultants to promote their own business en transfer knowledge to their clients were also beneficial for the PRT project.

A very special role in the process was played by the *province*. In The Netherlands the province is responsible for regional public transport and the allocation of subsidies on exploitation and on innovation projects. The Province of Noord-Brabant is engaged in an innovation program they have set up for public transport. Although the scope of their program is aimed more on the short and medium term, there were sufficient similarities between their goals and the *Transport System of the Future* scope. There was also a good match with the methodology applied by the province in their innovation process: the province used creativity workshops with stakeholders, organized pilots and demonstration projects. The project of *Transport System of the Future* fitted very well in the current activities of the province and could be considered as a part of the current program (van Zuylen et al, 2001).

A disadvantage of the match between the provincial plan and the Eindhoven project was that the province put much emphasis on participation and involvement of all stakeholders. The previous phase of the project has shown that interaction and participation should be limited and organised with much care to avoid slow progress. This difference in approach did not create many problems, however. The PRT project group quite naturally limited the interaction with the environment to the necessary level.

3.2 The pilot preparation

3.2.1 The Province of Noord-Brabant adopts the project

After the initial research phase, the leading role had to be taken over by another party with the role to stimulate the different actors to cooperate in a pilot. In 2000, the province took this role, she translated the vision of the future into the actual specific situation in Noord-Brabant. She took care of the transformation of ideas to plans for a pilot, the choice of a location and she formulated the requirements and success criteria for the pilot. A very important role of the province was to set up the regional network of stakeholders and to search for opportunities to involve new actors, necessary for a successful pilot.

In December 2000, the campus of the Eindhoven University of Technology (TU/e) was selected from 18 potential pilot locations in the province of Noord-Brabant in an interactive process. This site was selected because it comprises a great many elements of the inner city environment, such as park-and-ride, a connection to a public transport hub (a railway and local and regional bus station), the intersection of a through road and a pedestrian precinct. It offered the least complexity and few barriers to the implementation of PRT, as the length of the proposed PRT route (between the central station and TU/e) is relatively short and only two stakeholders are involved (the municipal council and the university). The TU/e campus provided a controlled test environment and the administrative support was available from the stakeholders in question. Moreover, the pilot project seemed financially feasible with low investment costs.

The drawback of the choice was, that the pilot would not solve any real transport demand, since the distance between the railway station and the university campus is short and most public transport users are walking the short distance between the station and the university.

A strong aspect of the choice was, that both the Technical University Eindhoven and the Municipality of Eindhoven wanted to be leading in technology and PRT would improve the image of the university as well as the city.

In the Eindhoven case, it was essential to ensure co-operation between the municipality (owner of the property along part of the route and responsible for urban development), TU/e (property owner, knowledge provider and an interested party in the new transport facility) and the regional cooperation council ‘Samenwerkingsverband Regio Eindhoven’ (SRE), a joint venture for the region of Eindhoven. SRE is responsible for public transport in and around Eindhoven and the economic stimulation policy for the region around the city with a large amount of knowledge-intensive industry and the automotive industry. The project was also designed to fit in with national government policy goals.

3.2.2 The innovation champions

The leading people that took the role as innovation champions were the (former) mayor of the city of Eindhoven, the alderman of the city responsible for urban traffic, the (former) chairman of the board of governors of TU/e and the (former) alderman of the province responsible for public transport.

Eindhoven's mayor and alderman saw PRT as a feeder for the new high-quality public transport system called Phileas[1]. Officially, there was also the possibility that the PRT system would link the TU/e campus with the city centre located behind the station. This would allow visitors to the city centre to park on the TU/e campus on weekends, late night shopping evenings and travel to the centre by PRT.

The chairman of the *TU/e* Board of Governors was no less enthusiastic. The new transport link would play an important part in improving the integration of TU/e with the city, so that it could be used more frequently for cultural activities. It would be an attractive link with the station and between the buildings on the university campus, a major advantage now that cars had been banished to the periphery of the university grounds. The pilot project also complemented TU/e's image as a knowledge institute.

At *SRE*, the chairman of the Executive Board was keen to support the pilot project, initially because PRT could become a feeder for the new local high-quality public transport system Phileas. Later, his motives shifted to a more commercial perspective, due to the opportunities for stimulating innovative trade and industry in the region resulting from the development and construction of a PRT system.

The provincial government acknowledged the potential of PRT to improve living conditions and accessibility in the urban ring in Brabant. The promise of a more economical public transport system that also appeals to the customer was to help that system escape from the negative spiral it was caught up in. The pilot project was to embody a piece of the future and serve as a 'laboratory' for other experiments such as methods of payment and information supply. The stimulation of innovative business in Brabant was also seen as a golden opportunity.

3.2.3 The funding

The costs for the pilot definition were shared by the provincial government, SRE, the municipal council and TU/e, with a 50% subsidy form the central government.

Apart from the national funding of the project, the European commission has set up the project EDICT in the fifth framework program. EDICT aimed for the introduction of Personal Rapid Transit as innovative public transport in medium sized European countries. Some of the actions that could support the Eindhoven project were part of the EDICT project and would be financed partly by the European Commission.

3.3 The development of the pilot

3.3.1 The leadership

In the initial phase of the pilot project, the leading role was given to TU/e. However, after some month the steering group concluded that it would be better to give the leading role to the province. The argument to have TU/e as leading party was, that they were owner of half of the pilot site, and the municipality, owner of the second half, did not have sufficient staff to take the leading role. After some months it appeared that an organisation like the university, experienced more in leading R&D, are less equipped to lead a pilot with participation by local and provincial authorities.

The initial approach of TU/e was to involve as many researchers and other experts as possible. Soon it became apparent that this decentralised development of the study

[1] Phileas is the name of a new public transport system that is developed with support of the national government, the municipality and the province. Busses are developed that have automated lateral guidance such that they can manoeuvre accurately along stops and have a kind of electronic rail. Their performance is similar to a tram.

structure was unmanageable and costly. The idea that the different working groups would become 'self organizing' appeared to be unrealistic.

The provincial government's basic premise that the local partners should cope with the responsibility for the project had not panned out, at least not in this strategic phase.

After the reorganisation of the pilot project the participation of the TU/e became uncertain due to serious temporal financial problems requiring a series of significant cutbacks. The chairman of the Board of Governors confirmed his support for the pilot, but he was to retire within a few months. His successor announced that there would be no room for a pilot project with a new transport system in the university budget or on the university campus. However, the present chairman assured that TU/e would continue to support the project, despite the temporary financial problems.

The province took over the leadership of the pilot. However, the city of Eindhoven and the TU/e kept many doubts that were not pronounced nor solved.

3.3.2 European tendering

The study for the definition of the pilot had to be executed by a consultant, since the initial approach to have it executed by a large group of experts had appeared to be unrealistic. The budget for the pilot definition study was more than the limit for European tendering. Although there were several arguments to avoid European tendering, the steering group demanded that the study would be tendered according to the European standards.

European tendering has a strictly prescribed procedure for announcing the tender and to evaluate the bids. Several actions are required and format of the tender were precisely prescribed. Organisation with more knowledge about the project because they had been involved in a previous stage had to be excluded or other bidders should get the same knowledge. In fact one could conclude that the European requirement for tendering stimulated knowledge loss, since organisations with most specific knowledge about the project were excluded unless special measures are taken. European regulations appear to stimulate ignorance in innovation projects. It would be good to change these regulations for innovative projects. Furthermore, the process of European tendering requires much knowledge of bureaucratic rules and causes many uncertainties for organisations that have to follow the process for the first time. The time and expertise that had to be allocated for following the European regulation were at the cost of time and expertise needed for the pilot study.

Many bids were received and assessed by the project team according to criteria that had been precisely defined. Even though the assessment procedure seems to be objective, it was clear from the assessment that personal preferences determine the outcomes. First of all, outcomes from peer reviews and assessment like this are determined for 50% by the personal traits of the assessors and for 50% by the qualities of the proposal. Secondly the phenomenon exists of *halo* and *horn*. This means that assessors are inclined to be biased in giving their opinions on certain aspects by their general impressions. If they do not like one single aspect of the proposal, they will give a lower score on other aspects even if they have no relationship with the other aspect. The same applies if they like a specific aspect of the proposal.

The conclusion from the European tendering procedure are not positive. The regulations excludes the most experienced bidder, stimulates the loss of expertise and creates a lot of additional work. The intended objectivity of the selection procedure cannot be proven by scientific methods. The risk to ignore the European requirements are high and most legal advisors prefer to remain in the framework of these regulations.

For innovation project these European requirements are a burden. The original goals might have been sincere, but the people who defined the regulations probably have not been aware of the drawback they create for projects like this.

The project wasted three months at least. In these precious month changes occurred at the level of the steering group, where the influence of the initial champions faded away.

The Eindhoven alderman announced that the PRT pilot no longer had priority. The Board of Governors of the TU/e made known that the pilot project no longer had priority and that they were actually not even interested in it. Provincial alderman for public transport, up to this point a stable factor, stimulator and steering committee chairman, left the provincial government. His successor did not have the strong motives, although he continued the support of the province.

When the consultants were selected for the piolo0t study, the university suddenly announced that the university campus was no longer available for a pilot project for PRT. TU/e indicated that the Master Plan for the development of the TU/e campus had no room for the new transport system. The other partners considered any further study to be a waste of time now that the pilot project could no longer be completed and the project as a whole was terminated.

3.4 In summary

To sum up, one could say that in 2001, the PRT pilot Eindhoven was born with the proverbial silver spoon and had a glorious future. With its Personal Transport of the Future programme, the province of Noord-Brabant was looking for innovations in public transport and a PRT pilot would be ideal. Eindhoven municipal council was keen to play a leading role in the technological innovations and the TU/e wanted to make a name for itself in the same field. The pilot project would also fit perfectly into the restructuring plans for the TU/e campus.

That silver spoon was personified by various leading administrators: the member of the Provincial Executive, the mayor of the city of Eindhoven, the chairman of the Board of Governors. As these key figures left the scene and the silver spoon was gone.

This means that there is no longer any benefit in conducting the pilot project in Eindhoven or possibly in Brabant as a whole. Then argument that the university campus would be a simple, riskless environment for the project was not valid any more.

4 Process analyses

4.1 Why do innovation processes fail

The failing innovation process of the PRT pilot in Eindhoven is not the only one, on the contrary, innovation in transport is a well known area of barriers. Several researchers and practitioners have thought about the frequent failures and possibilities to improve the innovation process and its conditions.

Recently the TRB Committee on Technology transfer published a report of a work group on Optimizing the Dissemination and Implementation of Research Results (TRB 2003) in which a comprehensive list is given of problems, their causes and remedies in innovation processes. Most important for the evaluation of the innovation process in Eindhoven is their list of causes why such a process does not reach the intended goal. The work group distinguished four classes of problems: policy, people, procedures and equipment. The following issues were identified (slightly adapted by the authors):

1. Policy
- No policy exists for research and innovation
- Contracts don’t stress implementation

2. Funding
- Innovation not in job description of everybody involved
- Not-invented-here syndrome
3. People
- Champions retire
- Users too busy to participate
- No link to future customers
- Lack of trust to deliver
- Researchers don't recognize value of their results
- Stakeholders don't recognize the problems
4. Procedure
- No meetings to keep people engaged
- Process hijacked by university / researchers
- Missing procedures
- Culture of change is not adequate
- Wrong person, wrong level
- Appropriate training
- Too many or too long meetings
- Not sufficient alternative techniques applied and insufficient redundancy
- Results are not distributed
5. Politics
- Benefit insufficiently clear
6. Equipment
- No testing equipment

Some other issues were mentioned, but the list given above gives a good initial framework to look at the innovation process in Eindhoven. It is clear that most problems have been dealt with in some way:

- There was in Eindhoven a well defined innovation policy of all stakeholders,
- Implementation was the explicit goal of the project
- Funding of the present part of the project was agreed between the participants,
- User were involved
- Procedures were well defined
- Researchers knew the potential of PRT and the need for a pilot
- The researchers had a modest role and the representatives of provincial, municipal and regional authorities were the most important players,
- The steering group and working group had representatives of the right level,
- There was a well defined publicity program,
- A test site existed on 2 hours travelling from Eindhoven (in Cardiff).

Still the process failed due to some issues mentioned in the TRB list:

- Champions retired
- Politics changed
- The whole process took too much time due to prescribed procedures

Not all representatives of the authorities had innovation in their job description and often their superiors doubted whether they should be involved in an innovation process like this.

The conclusion of a check list like this and also the one that is described in the next section is that innovation processes will not automatically proceed in the right direction if

the problems are identified and solved in an early phase. Several uncontrollable and unchangeable risks exist.

4.2 Ex post risk analyses

4.2.1 Introduction

A pilot development study like the PRT pilot study in Eindhoven has several risks that have to be managed. Now the project has failed, one could look back and try to identify the risk factors in the project that could be improved and, if recognized in an earlier stage, might have saved the project or had prevented that the project had started. The analysis presented in this section is based on a checklist developed at Harvard business school for the development of information systems. We have adapted the list for the evaluation of this project. This analysis is more technical than the one described in the previous section.

It distinguishes five categories of risks:

1. The size of the project
2. Level of innovation in the different organizations
3. Technical problems
4. Project organization
5. Project conditions

For each of these categories a check list has been used to identify whether the risks were high or low on a number of factors. Then the risk level is calculated. For example, if 6 factors out of 12 are identified as risky factors, then the risk level is 50% for that category. As an assumption, all factors are counted as equal weight.

4.2.2 The size of the projects

The project was a part of a long term innovation process and has been created to be of limited size. In advance, it was assumed that the study could be executed in a short time by an experienced team, the number of people to be involved was reasonably small and the project could be executed in a time that made change of staff unlikely. The definition as a feasibility study could be done without a strong interaction with other projects, apart from EDICT.

Still the size of the project had risks. Too many organizations had responsibilities: the municipality, the region Eindhoven, the university, the province and EDICT. The shared responsibility with EDICT has been well handles by a clear co-operation plan, but each of the other partners were completely free to choose their policy and to change the way they took their responsibilities.

On the level of the staff for the project the situation was very risky in the beginning, since too many working groups were created with no effective coordination mechanism. Since these people came from many different organizations, the cooperation would only become successful after a long learning and adaptation time. Also later the involvement of project team members was risky because they came from different organizations (especially the culture in the civil servant environment and the universities is very different) and they were involved only part-time while having many other obligations. Something has been improved by the fact that, after one year, the representatives of the municipality and the province got more time budget for the project.

Check list size of the project

Positive conditions in the project were:

- A relative short time scale (less that 12 months for the evaluation study)
- The manpower involved was reasonably small (less than 10 person years)
- There was no strict deadline
- The total time scale was not too long that we had to fear staff changes
- There are no dependencies on other transport systems
- The number of full-time staff members was small, less than 5
- Risk factors in this category are
- The members of the project team in Eindhoven did not have sufficient time
- There were (initially) many subprojects
- The initial situation had working groups consisting of members coming from different organizations
- The responsibilities were distributed over many organizations
- The responsibilities for the next phase, the implementation of the pilot were not clear
- More than 80% of the people working in the project were part time.
- The conclusion is that the size of the project had a 50% risk in the initial phase, but that the new project structure without project groups and only the EDICT partners and possibly one consultant would reduce the risk to the 30% level, which is rather low.

The fact that the project was only a step in a long term innovation process, made it difficult for some people to understand why certain decisions had to be made in the way they were. It was not clear what the next step would be and this uncertainty put stress on the project.

4.2.3 Level of innovation

The PRT project was innovative to a certain extent, but the innovative aspects have been reasonably well managed. End users did not have a real impact on the pilot: even if nobody would use the PRT system, it would still be useful as a demonstrator. The PRT pilot system would not depend on other transport systems, even though in future the integration with the train and bus would be an important issue.

The research to be done seemed quite adequate to assess the possible merits of the PRT system and the technical feasibility was proven by the pilot system in Cardiff.

Still there are problems with the innovative aspect. In The Netherlands PRT has been studied many times, but never the plans have resulted in an operational system. An automated bus exists already at Schiphol and Rotterdam. People could understand that the technology of PRT has a good perspective. But still the pilot would be a new technology for The Netherlands. No legal requirements and regulations exist for PRT.

The knowledge about our future users was limited, even though an assessment has been made of their willingness to pay.

The present organizations for public transport have no experience and it is still unclear which organization would take the lead in the implementation and exploitation.

This leads to the conclusion that the innovation aspect of the project gives certain risks, but that during the project measures have been taken to reduce these risks.

Check list Level of innovation

Positive factors are

- There is a working prototype of the system (in Cardiff)
- Some participants in the team had some experience with the pilot study
- End users were not involved yet
- There was no dependence on other projects (apart from EDICT)
- It was possible to make a good estimate what the value of the system would be for the operator and the users
- Future users had a positive attitude

Negative aspects were

- It was a completely new system for The Netherlands
- New organizations are necessary in the future and new ways of operating the system
- New standards have to be made
- Stakeholders have to be involved
- Complicated regulation applicable
- We do not know much about the future users

Also here the risk is moderate (50%). Several uncertainties exist and the chance to change them is low. The innovation aspect is therefore a subject of concern.

4.2.4 Technical problems

The technology of PRT still gave some concerns and risks. Measures have been taken to deal with that. The pilot location Eindhoven has been selected because there the consequences of a failure of the system would be small: people could still walk. Furthermore the technology of PRT is available and vehicles, infrastructure and control system can be built using existing components.

Still the vehicles are new for Eindhoven, suppliers still have to be identified and the relation between the supplier and the city and university has to be established. This is a risk for the future. In the future the system has to be integrated in the present transport system. That will give new risks.

The technology aspect is a very risky one. Measures to mitigate this might be to work in more close cooperation with EDICT and the suppliers of that system or to start with a system with a proven technology for The Netherlands.

Check list Technical problems

Positive aspect were

- Failure of the pilot system is not fatal: people can still walk
- The PRT can be built using standard components
- Negative aspects are
- Totally new, different infrastructure and vehicles will be used
- There is still no customer-client relation with the supplier
- Several changes will be needed in the rest of the transport system
- We have no experience with these systems
- The risk level is here about 70%, which is quite high. It might have been better to start with a technology that was already applied in The Netherlands with an option to make the transition to a more advanced PRT system.

4.2.5 Project organization

The project was initially very fuzzy: the task was not well defined and the boundary conditions could be (and have been) interpreted in different ways. In a project like this

the leading party should be experienced in innovative projects, in political process, and have technological knowledge. If this is not the case the leading party should rely on experts with the necessary skills and knowledge. This leader must generate speed and financial commitment from all parties.

The initial project leader had no experience in the technology nor in the process. Especially the knowledge how to manage a process with much interaction with the environment was not present. This risk factor was partially removed by the first crisis: the boundary conditions, objectives and working process have been clearly defined. The steering group assigned new project leader.

Still the project group was rather weak because the knowledge about the technology and the possibilities of PRT were concentrated in one or two members of the team and even there the level of the knowledge about technologies was superficial.

A weakness of the whole organization was the fact that the members represented provincial and municipal authorities and the management of the university. A representative of the research world was also member, but the future users or the suppliers of future exploiters of the PRT system were not involved.

The project organization was very risky at the start and also after the first reorganization several risks remained.

Check list Project organization

Positive is

- The chance that requirements would change was not too big
- Procedures exist to control changes in the project
- The problems are in the following aspects
- No experienced project leader in the project group most of the time
- No technical knowledge in the project group
- No participation of future users or future suppliers
- The risk is apparently rather high (60%). A different project group with more technical knowledge, a professional project leader and participation of users and suppliers would have strengthened the project.

4.2.6 Project conditions

The conditions in Eindhoven were initially chaotic, since no clear rules existed with respect to the execution of the project. The involvement of external experts to review the project could help to improve the conditions.

The commitment of the stakeholders was a big risk. The key persons at the university, the province and the city left and their successors were not equally committed. During the first year of the project the reasons to participate in the project became weaker and new priorities emerged for the university and the municipality. The project team members did not have much time to spend for the project and their commitment became less especially when the execution of the study was delayed.

The project leader was not able to improve that situation. She could not improve the motivation of the project team and could not change the commitment of the municipality and university.

Check list Project conditions

Positive aspects of the Eindhoven project are

- There were rules to execute the project (after the initial, rather chaotic phase)
- The project products would be reviewed by external experts
- Negative aspects are

Insufficient commitment of all stakeholders

It was likely that priorities would change during the project

Availability and motivation of project team members was not sufficient

Changes of key persons

The conclusion is that the risk level is high (70%) with little possibilities to improve. The low speed of progress is an essential reason of negative aspects: commitment is diminishing when no results come out of many months of work, key persons leave and requirements can change the longer the project lasts.

4.2.7 Conclusion

The conclusion from the check list is that the first reorganization of the project – where the many working groups were eliminated - has improved the situation. The plan to have a professional project leader for the technical work would also be a good improvement. The most critical aspect is, however, the low speed of progress due to the many requirements that had to be satisfied, especially after the first crisis.

4.3 Institutional factors

4.3.1 Social dilemma

The risk and costs of an initial introduction of PRT were too high for the current project participants, which is why government support was crucial at this juncture. Local stakeholders hesitated before joining or staying on the project due to the lack or loss of local budgets to pursue or complete these kinds of projects and due to insufficient prospects of other budgets becoming available. Furthermore, the short-term benefits of a pilot project at local level could hardly offset the huge risks and costs of the innovation process. This innovation process often demonstrated that local partners were willing to make space available, but that it could not be expected they would plan and finance a process of innovation for which the rewards would be reaped at national and international level. A classic social dilemma.

The solution would be to find a party that thinks it can make money on the introduction of a single PRT system. Thus it would be necessary to find a method with which the commercial party can benefit and the social good can also be served. The idea of the Netherlands Ministry of Transport that ‘the market should make the innovations’ does not apply to system innovations like PRT.

4.3.2 Market parties

Market parties were expected to have more creativity, capacity for initiative and expertise in technological innovation than the government. Early collaboration with market parties was considered essential, but was severely hampered by European legislation. Companies that had been involved in the project at an earlier stage had acquired inside information and faced the risk of being excluded from the further tender procedure, unless the inside information and a company’s plans were made public in the tender procedure for subsequent phases. This made it very unappealing for companies to join the project at an early stage.

As a result, the initiative trade and industry have to offer was not made available to the pilot project, entailing the risk that the various authorities would draw up a programme of requirements amongst themselves that would be of no interest to business. It started to look more like a drab and dreary compromise than an ambitious, creative challenge.

The fact that the participants were so unused to innovative projects resulted in compulsory compliance with extremely strict regulations that could probably have been applied more liberally. However, the advisors of the public authorities did not dare to take the risk of a more liberal strategy.

4.3.3 Tender trouble

The regulations of European tendering led to an eight-month delay, considerable costs, a loss of expertise and frustration on all sides. The approach was kept rigid to avoid administrative risks which resulted in slow progress and obligations for bidders that left them with enormous costs when the project was eventually terminated.

A more free interpretation of tender regulation can help innovation processes. This is also recognised recently by the European Commission. A Technical Dialogue is under construction, this regulation should provide solutions for this dilemma.

4.3.4 The role of the government

Central government and regional/local government have not yet sufficiently clarified their role in innovation management. They refer to each other if decisions have to be made. They wait to join until the other is giving support. This is counter productive as well.

5 Conclusions and learning experiences

A number of arguments that formed the basis for the choice of TU/e as the location for the pilot project later proved to be invalid. Support for this kind of technical *tour de force* on the TU/e campus in Eindhoven quickly dissipated.

The fact that the project could fail technically played a key role in the selection of the pilot location. TU/e had a fallback option (walking) and scored well. The need for a transport system was minimal, however, and this presented a major administrative risk of damage.

More generally spoken: the leading party in an innovative project should have a big interest in the project, that is likely to weigh up to the risks. In the Eindhoven case, local parties were loath to play a leading role in an innovation process in which they bear the risks and burdens but reap only a small portion of the short- and long-term rewards.

Structure of the innovation process

The DTO method makes the innovation process more transparent by linking long-term goals (elsewhere and later) to local goals and interests (here and now). ‘Upwards scalability’ is, therefore, one of the preconditions for the local pilot project. It has become apparent that this project design is hard to follow when the project has to be worked out in detail with local parties.

The slowness of the interactive innovation process is a major risk, since priorities of today will be out-of fashion tomorrow.

The initial approach that further studies would not be necessary did not convince the policy makers in Den Haag and Brabant. The pilot represented a lot of uncertainties and risk. The natural reaction of risk-avoiding decision makers in such stressful situations is to slow down the process and to demand more studies (Hofstede 1984).

A technical isolated demo (like Cardiff) could be a necessary step in between to provide familiarity with the system, robustness and speed in the innovation process.

According to the DTO method, it is vital to involve various parties in different phases of the process. In Brabant, a lot of work went into translating this approach into a workable process design for the plan detailing. After all, no satisfying way was found to involve business parties in the pilot development.

The Eindhoven case is a top-down innovation process initiated from research, which is why it was difficult to find local leaders and co-funders in government and business.

Role of the government

The chance of success of local pilot projects for system innovations can be enhanced if the national government plays a stimulating role. There is a need for vision and policy for system innovations and a more clear-cut strategy for the selection of innovations. This vision and policy should be supported by business parties and social organisations.

The national government should not only facilitate the compilation of development plans but also their implementation. At the moment, there are not enough funds available for the implementation of pilot projects whereas there are stimulation programmes for plan development. The government can also consider risk compensation for investments in innovation.

Every step in the innovation process of city transport should be inseparable from the total vision for the future of these cities. It would be ideal if a town would provide a traffic policy in which PRT is a useful element of the transport system filling a relevant niche and offering a favourable option in comparison to the car. The Eindhoven case was not providing such a visionary base.

The provincial government can play a stimulating role by bringing innovation partners together.

The government coordinates knowledge and experience in innovation. This is an important element of stimulating innovations. However, this task has not been taken up sufficiently.

The government is having too many access points for innovation; economic, environmental, mobility counter etc. contra productive. There should be one counter for innovation.

Central government and regional/local government have not clarified their role in innovation management. They refer to each other if decisions have to be made. They wait to join until the other is giving support. This is contra productive.

Leadership

The government should be an important leading party in long term innovations because of the long term ambitions, the long period for return of investment, the considerable risks, and the consequences for the design of public space and the articulation of societal needs.

The government should not be the only leading party in such a project. They should share the leading role with NGO's.

The leading party should be experienced in innovative projects, in political process, have technological knowledge. This leader must generate speed and financial commitment from all parties. The leader should also take care of the necessary lobby work. This leading party was missing in the Eindhoven case.

An external project manager may be better suited. The release of local funding to take on such a person has proved difficult in the preparatory stage.

Regulations

European regulations discourage private partners from becoming involved at an early stage.

Tendering regulations have been drawn up for and by jurists and accountants but offer little assistance to the project manager and process manager. They delay the innovative

process and cause discontinuity in the progress. They curb the urge to invest and contribute to the loss of knowledge. A more free interpretation can help innovation processes.

Political process

In the Eindhoven case, the administrators were unfamiliar with and unskilled in innovation processes.

The political process is becoming increasingly complex and protracted as the material becomes more complex and the number of interests and interested parties grows. This also increases the risk of key figures disappearing from the stage and the process stagnating.

The political process is (also) a game of personalities. The priorities put forward by the key figures are not always shared by the organisations they represent. This leads to discontinuity when they are ordered to follow the organisational rules.

Two characteristics of Dutch government culture create an additional obstacle for innovation: everyone has to have a say and (European) regulations are enforced to an excessive level of strictness.

The commitment, skill and expertise required to set up an administrative joint venture were seriously underestimated. This refers to commitment and expertise in the field of interest management, lobbying, and the practical and judicial development of collaboration in terms of responsibility and project organisation. The intensity and costs of this supervision are also hopelessly underestimated.

General

An innovative process is permeated with imponderables that cannot be listed and evaluated systematically. Those responsible for managing the project must have the knowledge and experience to deal with these imponderables. A regular inventory of the risks and opportunities may serve as a useful supplement to the DTO method.

The communication should include a selection procedure to decide who is to be involved in the process at what time. When working together, the core group should be kept to a minimum.

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