

CHAPTER 6 FRAMEWORK

6.1 Introduction

This chapter introduces a framework for the explicit use of specific systems thinking methodologies_{1&2} in data warehousing practices. The aim of the framework is to improve data warehousing practices by providing methods based upon such systems thinking ideas. The framework also represents the reconstruction part of the critical social research methodology for this study described in chapter 2, section 2.5.2.

The framework represents research that combined three resources, namely a literature study on systems thinking methodologies_{1&2} (presented in chapter 3), a literature study on data warehousing concepts and success factors (presented in chapter 4) and case study research conducted to understand to what extent current data warehousing practices reflect systems thinking methodologies_{1&2} (presented in chapter 5). The framework should thus not be read in isolation from the mapping between specific systems thinking methodologies_{1&2} and data warehousing practices given in section 5.2.

This chapter represents a specialisation of the practice layer in the philosophy, methodology₁, and practice model used in throughout this thesis.

The framework presented in this chapter constitutes three different frameworks. Although one basis figure is used, it is viewed through three different lenses resulting in frameworks for soft, critical and disclosive systems respectively. Although the case study results indicated some hard systems practices used by industry professionals, respondents in managerial positions highlighted the problems resulting from these hard systems thinking practices. The researcher therefore chose to focus on the other systems thinking methodologies_{1&2} investigated.

The chapter begins with a description of a data warehouse as a system in section 6.2. In section 6.3, the framework is then introduced gradually, according to the different aspects of a system proposed by Churchman (1968), to aid the explanation. Although the work of Churchman (1968) can be categorised as soft systems thinking, critical systems thinkers such as Ulrich (1987) acknowledges the critical aspects in Churchman's work. Each section of the framework is initially presented from a soft

systems view where after it is viewed through the lenses of critical and disclosive systems thinking respectively.

An important aspect in the application of the three methodologies_{1&2} in data warehousing practices is that although different methodologies may lead to similar practices, the practitioners' motivations for choosing such practices are rooted in different ontological views.

The discussion of each section of the framework concludes with references to the answers of the respondents of the various case studies to illuminate the guidelines given in that section. The analysis of the case study data given in chapter 5 indicated mostly soft systems motivations for practices. It was argued in section 5.5 that although fewer critical and disclosive systems answers were given, the use of these methodologies_{1&2} may still be able to improve data warehousing quality.

The discussion in section 6.4 compares this framework to the existing frameworks of Wixom and Watson (2001) and Kimball *et al.* (1998). The chapter (and the thesis) concludes with a summary of the research study presented and a critical evaluation of the scientific progress made by this research study.

The purpose of the complete framework given in figure 6.1 is to guide the reader in building a holistic view from the subsections presented in this chapter. The division of the framework into parts is done from a soft systems perspective, following a hermeneutic method, and not from a hard systems perspective where the total is simply seen as the sum of the parts.

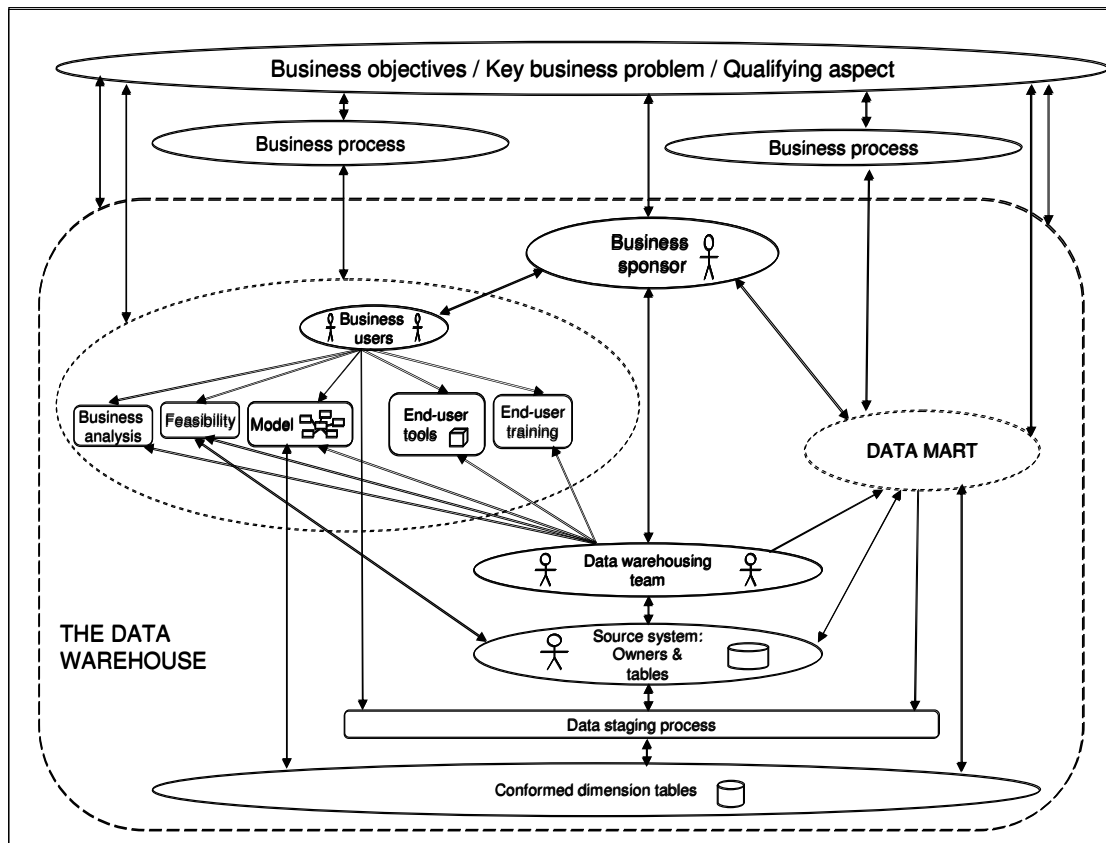


Figure 6.1 A data warehousing framework

6.2 The data warehouse is a system

As a soft system, the data warehouse should be defined in terms of its purpose and not its components. *A data warehouse therefore, is a tool to provide management information for decision making in order to achieve the overall business objectives.* The data warehousing framework (presented in figure 6.1) is not a true reflection of reality; it simply represents a view of a data warehouse to aid discussion of this tool.

The property of providing management with accurate information which is easy to access, is viewed as an emergent property of the total system (the data warehouse). The components of the system work together to realise this purpose, rather than being the summation of the individual properties of the parts of the data warehouse.

The stated purpose of the data warehouse can be viewed from a *critical systems thinking perspective* by focussing the business objectives on a single critical problem area in the organisation. In a typical critical systems environment, this problem area will be associated with intervention or emancipation, while in *disclosive systems thinking*, the qualifying aspect of the organisation would be central to the business objectives. The reader is reminded that the qualifying aspect of the organisation refers to the intrinsic meaning of that organisation such as patient care in a hospital.

The view of a data warehouse as a system was supported by all the case study respondents, when answering question A1 (section A, question 1 of table 5.1). Question D6 of the same table explored the acceptance of different views of a model. In this case, the respondents of case study three followed a soft systems approach, while the other two case study respondents gave mixed answers. The data warehouse is shown in figure 6.1 by the large dotted-line rounded rectangle.

6.3 Data warehousing according to the systems approach

This section describes the data warehouse framework presented in figure 6.1, according to the systems approach of Churchman (1968) discussed in chapter 3, section 3.2.4. In order to aid the explanation of the framework, a simplified version of figure 6.1 is associated with each of the system characteristics.

It should be noted that one cannot include all the business users in the process. Therefore, the business users indicated in this framework is a representative group of two to four persons.

6.3.1 The objectives of the data warehouse

Figure 6.2 indicates the relationship between the data warehouse and the organisation's objectives. The data warehouse is a subsystem of the overall system formed by the organisation. When viewed through the lens of *soft systems thinking*: the organisation's objectives (i.e. the strategic objectives of the organisation), are achieved by employing the various subsystems in the organisation, including the data warehouse.

To ensure that the data warehouse achieves the objectives of the organisation, role players from the executive committee of the organisation should form part of the data warehouse. The business sponsor (described by Kimball *et al.* (1998), referred to in section 4.5.1) fulfils this role. The business sponsor should be somebody who serves on the executive committee of the organisation and who believes that the data warehouse can assist in achieving the overall objectives of the organisation. The business sponsor should also be an influential person, able to motivate the rest of the executive committee to allocate enough resources to the data warehousing project.

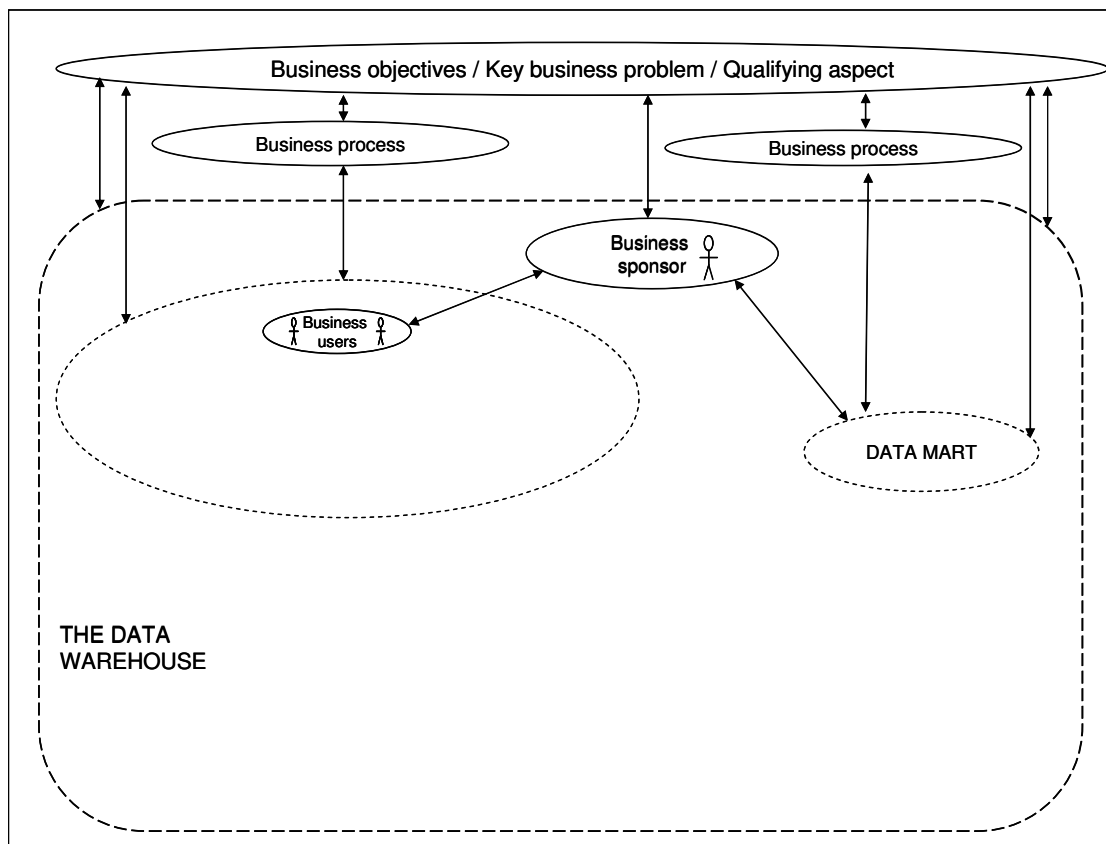


Figure 6.2 Data warehouse objectives

The most important role of the business sponsor is to ensure that the organisation's objectives are taken into account in all the activities of the data warehousing project, including the more technical activities, such as data staging.

Organisations need to divide their activities into smaller areas to provide effective management. Churchman (1968:40) as discussed in section 3.2.4.4 advocates the division of organisations into business processes, rather than traditional departments.

The division of the data warehouse into data marts should follow a similar pattern. The main reason for this is the realisation of overall business objectives of the organisation by supporting the objectives of its subsystems. Business users from each of the business processes form an integral part of each data mart.

When these practices are viewed through the lens of *critical systems thinking*, one should be aware of the underlying political agendas of the role players. The business sponsor should be chosen as somebody whose own personal objectives are compatible with the real objectives of the organisation. The business sponsor should facilitate the underlying structures in the organisation that should be addressed through the data warehousing project. One should also take care that the position of the business sponsor in the organisational hierarchy does not influence the effectiveness of the data warehousing project. This implies that decisions should still be reached by consensus and not be determined by the business sponsor's rank in the organisation.

When these practices are viewed through the lens of *disclosive systems thinking*, the objectives of the organisation should promote its intrinsic normativity. All the actions of the business sponsor, as well as those of business users from the different business processes, should be focussed on achieving this main objective of the organisation as a whole. One should ask: "What is the benefit of the data warehouse?" And even more important: "What benefit does the organisation bring to society?" Answers to these questions will lead to the disclosure of the intrinsic normativity of the organisation. The business sponsor should play a facilitation role in the process of disclosure of the qualifying aspect of the organisation and the supporting role of the data warehouse to this aspect of the organisation.

The role of business objectives was covered by a number of questions during the case studies. Question A3 (section A, question 3 in table 5.1), probed into the relationship between the overall data warehouse objectives and the organisation's objectives. All three case studies' respondents accentuated this relationship. Questions C5 and D3 investigated the relationship between the organisation's objectives and requirements analysis and data modelling respectively. Once again, most of the respondents agreed that the organisation's objectives are important in these phases. However, questions E2 and E4 on the relationship between the organisation's objectives and data staging revealed mixed results. Senior personnel of the organisations agreed that a thorough knowledge of objectives should form part

of the traits of a data stager. Technical staff members on the other hand, acknowledged that they do not know the organisation's objectives but believe they should.

The viewpoint represented by this framework stresses the importance of data staging team members fully understanding the organisation's objectives. It will aid in solving data quality conflicts, and it will make them more aware of requirements that are contradictory to the overall objectives of the organisation.

Most of the respondents agreed with the division of a data warehouse in terms of data marts that should correspond to business processes (refer to questions D4, D9 and D10).

From the answers to question E10 on the identity of data warehouse customers, it became apparent that a complete systems approach by the respondents has not been followed intuitively. Very few referred to the organisation's customers as the customers of the data warehouse.

When a true systems approach is used, i.e. where the business objectives are truly accepted and incorporated in the data warehouse objectives, the customers of the organisation will also be the customers of the data warehouse.

6.3.2 The environment of the data warehouse

Churchman (1968:35) describes the environment of a system as the factors outside the system that influence the system. These are the factors the system cannot control, but which has control over the system. In a data warehouse system, some people view the source systems as part of the data warehouse resources and others as part of the environment. This point is debated here in terms of data warehousing literature and case study results.

Figure 6.3 depicts aspects that are discussed in terms of the environment of the data warehouse. From a *soft systems thinking* perspective, there are four parties to consider when debating the environment of a system:

1. The organisation's management and their objectives
2. The business sponsor

3. The business users
4. The source systems owners responsible for the source systems

There is consensus that the organisation's objectives are initially part of the environment of the system. These objectives led to the initiation of the project. After extensive analysis of the data warehouse data, the management of the organisation might alter their objectives. Although the data warehouse, used as a tool in decision making, caused the change, it is not viewed as controlling the business objectives.

One might argue whether the business sponsor is not in the same position as the organisation's objectives. It is clear from the role of the business sponsor that he/she represents the data warehouse on the organisation's executive committee and all the proposals made to this committee by him/her is influenced by the data warehouse. The business sponsor is viewed as part of the data warehouse system and not of its environment.

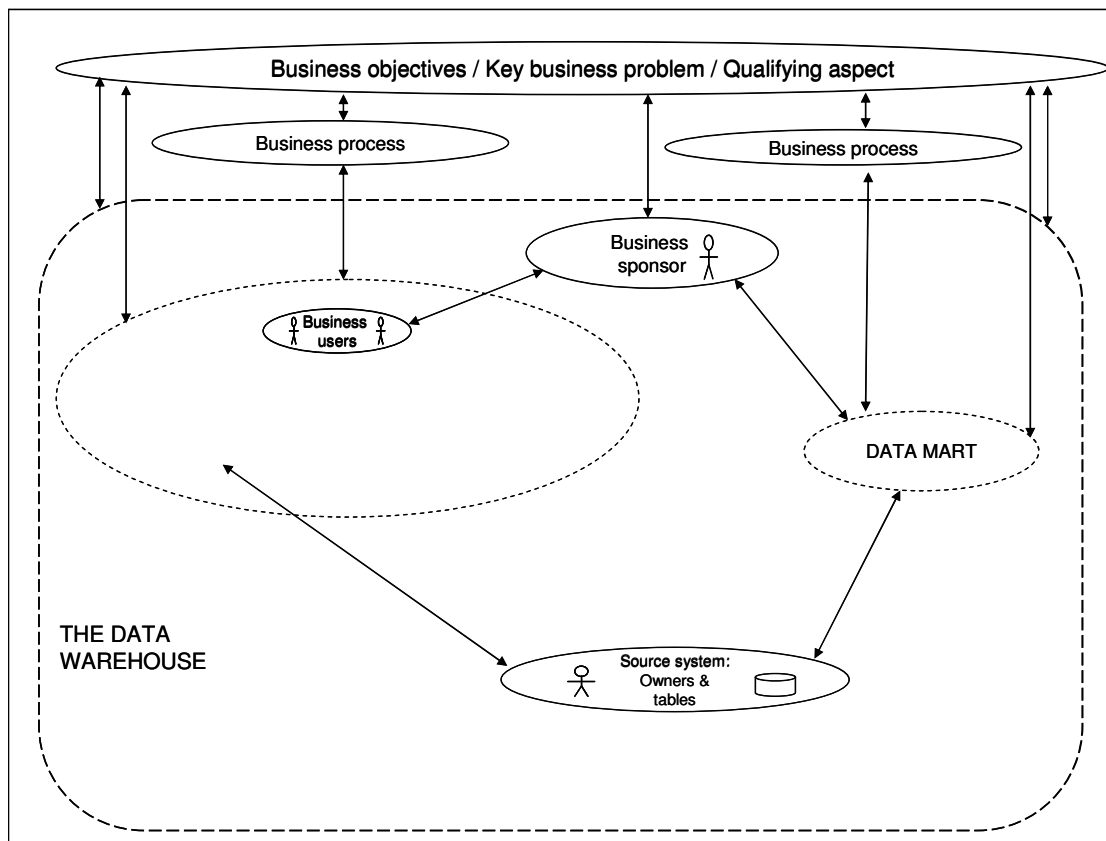


Figure 6.3 Aspects regarding the data warehouse environment

A similar argument can be used to show that the business users are part of the data warehouse as well. Question F7 of table 5.1 probed into the effect the data warehouse had on the business users. Only one respondent answered negatively, while all the others agreed that the data warehouse changed the way they do their work. In the second and third case studies, most respondents also answered that the end-user applications are part of the data warehouse (question F4). In response to question A5, most respondents agreed to at least a joint, if not sole, ownership of the data warehouse by the business users. It is concluded that the business users are part of the data warehouse system and not of its environment.

In the organisations represented by case studies one and two, the data warehouse was developed by a group of people outside the information systems department (question A11). The consultants of case study three reported that the development typically takes place in the information systems department by a specialised team. In response to question A6 on the influence of the data warehouse on other systems in the organisation, many respondents in case studies two and three reported on major quality advantages, if a feedback loop exists between the data warehouse and the source system. Kimball *et al.* (1998:329) also indicated such a feedback loop.

It is therefore concluded that the source systems and their owners are indeed part of the data warehouse. It is nevertheless of critical importance that data warehouse development is separated from operational systems development. This view is based on the data models used and will be discussed as part of the components of the system.

From a *critical and disclosive systems* perspective, the source systems and their owners will be more readily incorporated in the system. Critical systems thinking will change anything in the organisation to achieve the required intervention, while a disclosive systems approach will change anything (including the source system) that is opposed to the intrinsic normativity of the organisation.

6.3.3 The resources of the data warehouse

Churchman (1968:39) states: “Resources are the general reservoir out of which the specifics of the system can be shaped.” Resources are part of the system and it can be people, as well as physical instruments.

Figure 6.4 shows the resources of the data warehouse framework. Churchman's (1968:38) view that the potential of people also forms part of the system is strongly supported by this data warehouse framework.

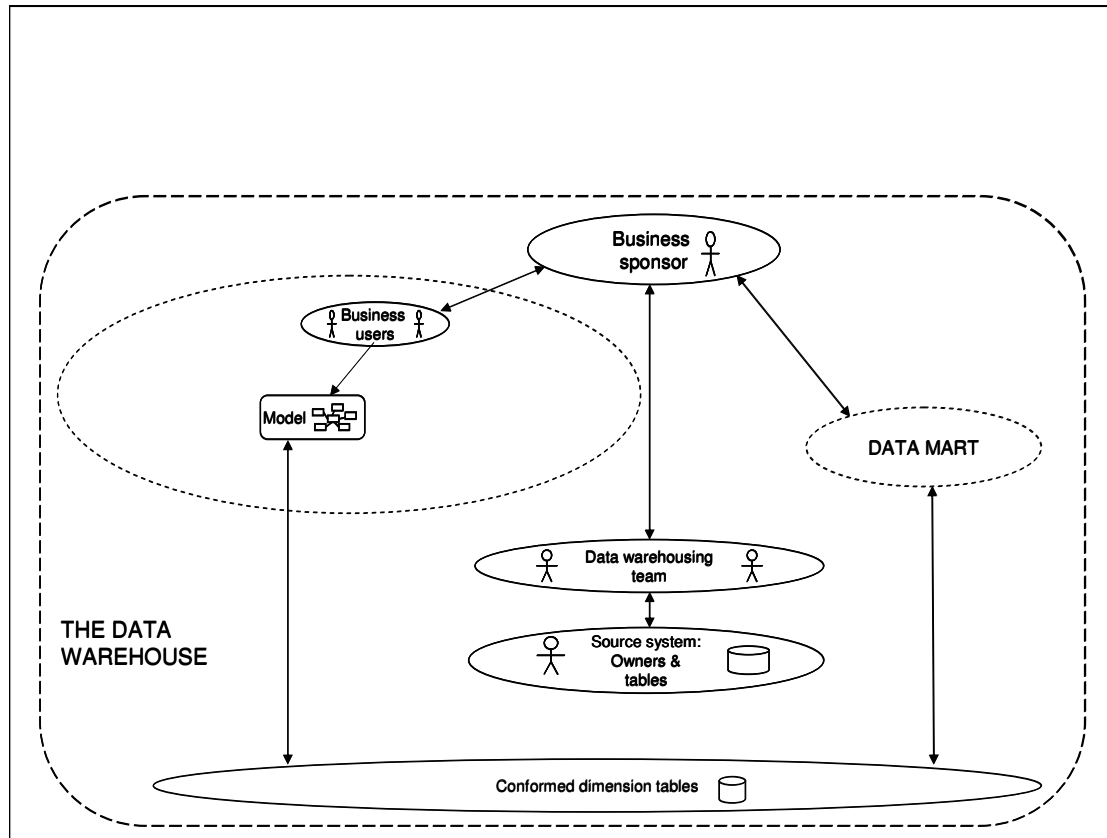


Figure 6.4 Resources of the data warehouse

The data warehouse system has the following resources:

1. *The business sponsor.* He/she provides insight into business problems and forms the gateway to the organisational resources.
2. *The business users.* Business users are the most important resource of information about the objectives of the system.
3. *The data warehouse team.* The team includes people to assist in all components of the systems as discussed in the next section. External consultants may form part of this group. It is of the utmost importance for the data warehousing team to understand the organisation's objectives.
4. *The source systems and their owners.* They are the main source of data for the data warehouse. The source system owners also provide input to quality

assurance activities during the data staging process (also discussed in the next section).

5. *The conformed dimension tables.* These are loaded from the source systems and form the data warehouse bus. This is similar to Kimball *et al.*'s (1998) view presented in section 4.5.3 and illustrated in figure 4.6. Each data mart does not contain a copy of the data, as it is stored on a shared location. The modelling process and the interaction with the conformed dimensions are discussed in the next section.
6. *Software tools and hardware.* Software and hardware are used throughout the data warehouse to manipulate and store the data. The main data store is the conformed dimensions. Each data mart contains fact tables with links to the dimension tables. All tables are physically stored on one or many computers. One might see the combination of fact and dimension tables as a presentation server congruent with Kimball *et al.* (1998:329). This data warehousing process is metadata-driven and metadata is also used to store information about the role players i.e. resources in the data warehouse.

It is important to identify the different worldviews of the people involved in the data warehouse. The respondents of case study two, when reacting to question B2 of table 5.1, reported conflict amongst the data warehousing team members as a result of different world views.

The business users are typically associated with a single business process and therefore a single data mart. The business sponsor, being a member of the executive committee, has an interest in all the data marts. The data warehousing team also has influence in all the data marts. Every data mart should not have its own data warehousing team, since it will be very difficult for such an isolated team to incorporate the overall objectives of the data warehouse and the organisation in their activities. Source system input is required in all the data marts, and specific source systems may provide input to more than one data mart.

From a *soft systems thinking* perspective, the organisation's objectives, supported by the data warehouse objectives, are the common factor that enables the different role players to work together. Soft systems thinking advocates an awareness of internal political aspirations and advises a method to resolve conflict and achieve consensus. The respondents of case study three stated that there is a variety of methods for reaching consensus, even in hostile situations (refer to question B2, respondent MC).

The above views were supported by the respondents of case studies two and three. Most respondents agreed (question A8) that people are part of a data warehouse and that the data warehouse is jointly owned by business and technical staff (question A5). Responding to user involvement (question C2), most participants agreed that senior management of business units should be involved in requirements specification. The organisation reported on in case study one, draws a much tighter boundary around their data warehouse. They view a data warehouse mainly as an organised data store. They also admit that many of their problems result from this view of a data warehouse.

The resources can once again be viewed through critical and disclosive systems thinking lenses. A *critical systems* perspective would accentuate the different agendas of the different role players. It is necessary to state for each of the role players what benefits they may gain from participating in the data warehouse. It is also important to highlight the differences in the real objectives of these role players. The technical staff's worldview, for instance, differs substantially from that of the business users (case study three, question B2). While soft systems thinking advocates the role of consensus to settle these differences, critical systems thinking admits that differences are difficult to identify and not always possible to be solved by consensus. Data quality and the influence of the data warehouse on the source systems were discussed in section 5.2.1.3.

Disclosive systems thinking is very similar to the soft systems approach, but the unifying factor would be the qualifying aspect of the organisation, as opposed to its quantifiable business objectives.

6.3.4 Components of the data warehouse

Churchman (1968:40) describes the components of the system as the different activities the system has to perform. The bold parts in figure 6.5 indicate the components of the data warehouse. These components form the development lifecycle of the data warehouse.

Most of the respondents agreed on the order of activities of the lifecycle (question B1). With reference to the data warehouse team, all but one of the respondents of

case studies two and three agreed on extended business user participation (question B3). They also agreed that consultants can only be beneficial when knowing and understanding the business objectives (question B4). Most of the respondents agreed with the division of the data warehouse into data marts according to the business processes (question B5) of the organisation.

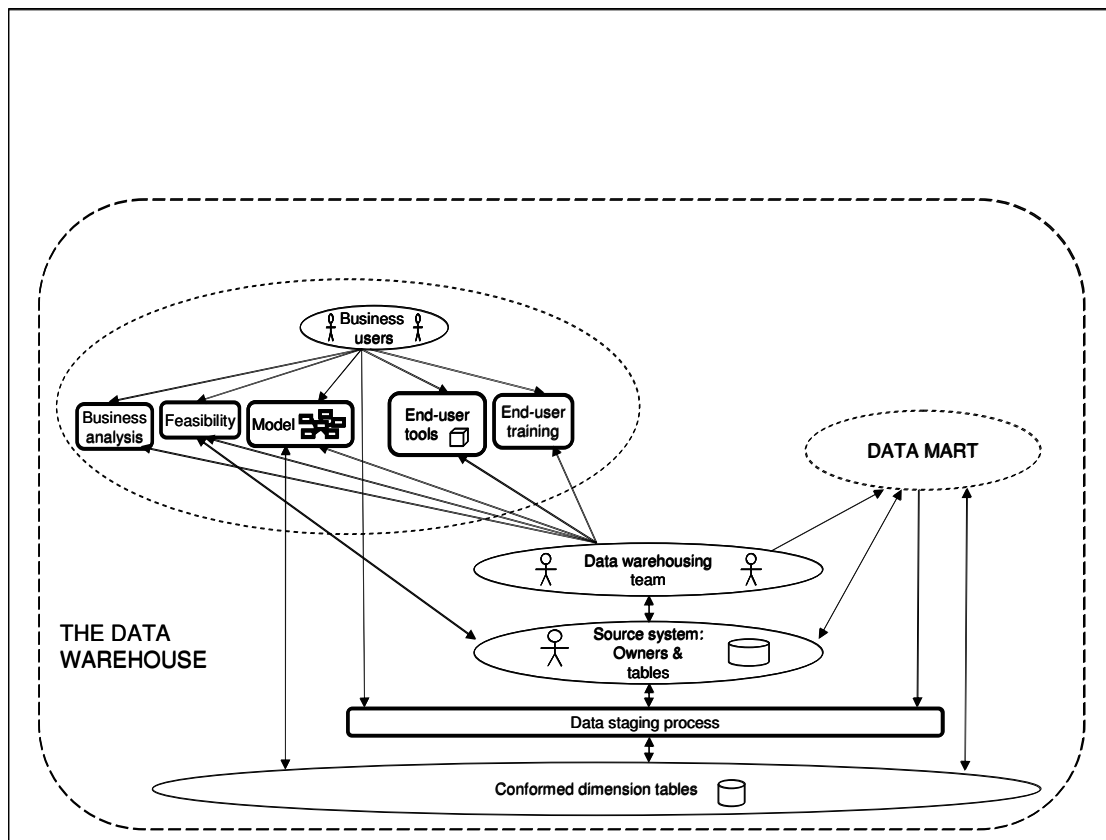


Figure 6.5 Components of the data warehouse

The organisation as a whole should be studied first, before identifying data marts. The performance measures of the data marts should be linked to the performance measures of the business processes.

6.3.4.1 Business analysis

From a *soft systems thinking* perspective, the first phase of data warehousing is to gain a complete understanding of the business. In this phase, the business users play a pivotal role, as indicated by all respondents to questions C1 and C2. There was also general consensus that users are unable to articulate their needs in

technical terms and need facilitation (question C3). The organisation reported on in case study one, using a hard system approach, often finds that users are able to express their needs only after completion of their data mart.

Critical systems thinking accentuates the view of one key problem area that needs to be resolved by the data warehouse (refer to case study three, respondent SC's answer to question A3). Consultants would typically take this approach, since it is easier to measure their success in terms of the solution to one such identified problem. The decision making structures as described in section 5.2.1.3 will be investigated during this phase. Ulrich's (1987) boundary judgements as described in section 3.5.3.2 will also be done during this phase.

A *disclosive systems thinking* perspective is similar to soft systems thinking, but with an added focus on the intrinsic normativity of the organisation. The entire organisation will be investigated in order to disclose the intrinsic meaning of the particular organisation. The lists of aspects given by Dooyeweerd, described in section 3.3.1.3 may aid this process.

The requirements documentation should be available to all role players, while procedures for updating the requirements must also be at hand (question C6). A computerised system if proposed for this function.

6.3.4.2 Feasibility study

A feasibility study should reveal how much of the data required by the business analysis, is available in the source systems. In this regard, the business users and the source system owners are important role players, since the business users understand what is required, and the source system owners know what is available. The availability of source data influences the prioritisation within the data warehousing project (question C7).

From a *critical systems* point of view, the data warehouse system would expect changes to be made to the source systems to accommodate the data warehouse objectives. From a *disclosive systems* perspective, the data warehouse team would be sensitive to the fact that historic and other factors beyond their control might influence the source systems. They would therefore accept shortcomings in the

source systems, provided they are not in direct conflict with the intrinsic normativity of the organisation.

6.3.4.3 Data modelling

Data modelling is the process of designing a star schema, to represent the views of the business users and the data warehousing team of the data required in the data mart. The responses to questions D1, D2 and D7 in case studies two and three indicated that users do not normally participate in data modelling, but it could be very advantageous if they would. The respondents reported that most users would understand the technicalities of star schema design.

There is interaction between the modelling team and the data warehouse bus of conformed dimensions. The modelling team designs dimensions to represent the user's needs. These dimensions must be compared with the existing dimensions of the data warehouse bus. The existing dimensions then need to be extended to contain any additional information required by the data mart.

From a *critical systems thinking* perspective, the users would want to be involved in all the phases of the data warehouse lifecycle, ensuring that their critical problem is correctly understood and solved by the data warehouse team.

A *disclosive systems* approach is similar to that of soft systems described above. The model is viewed as a tool for supporting the qualifying aspect of the organisation.

6.3.4.4 Data staging

Data staging involves the extraction, transformation and loading of source data from the source systems into the conformed fact and dimension tables of the data warehouse. The process may also update the source tables to improve source system data quality, since data quality is of the utmost importance to data staging. Firstly, it should be determined who is responsible for data quality. The respondents of case studies two and three indicated a joint responsibility (question E1); whereas respondent SC of case study three assigned the responsibility directly to the business users. Although this is a technical process, business users should be involved to ensure that data anomalies are resolved.

By taking ownership of data quality, the business users will be able to verify data values in the data warehouse, and this would enhance confidence in the data warehouse data. If the data warehouse users have confidence in the data warehouse data, they will use the data warehouse in support of their decisions, which is the most important success criterion of all.

The challenge is not to lose sight of the organisation's objectives in the data staging process. These objectives can only be reached if the data warehouse data is of high quality from a business user's perspective.

Critical systems thinking will highlight conflicting interests of source system owners and owners of the rest of the data warehouse system. The underlying motivations of these conflicts need to be exposed and resolved before the data in the data warehouse can be trusted.

Although the practices of *disclosive systems thinking* are very similar to the soft systems approach described above, conflicts between different source systems will be investigated in terms of the qualifying aspect of the organisation.

6.3.4.5 End-user tools

End-user tools are programs used by business users to access the information in the data warehouse. All respondents reported that these tools are very seldom developed in-house, and that they use standardised packages from large vendors (question F3). This increases the responsibility of selecting a tool that is acceptable to the business users. If the tool is too complicated to be used for the analysis required by the business users, the data warehouse will not be used and therefore be unsuccessful. A proof of concept can be applied to test the value of a specific tool. The business users should take actively part in the tool selection process.

Since *critical systems methodologies*₂ such as TSI discussed in section 3.5.3.1 provides methods for comparing different methods, the critical systems thinker will be able to critically evaluate different end-user tools in order to select the most appropriate tool for the specific needs of the organisation.

Since *disclosive systems thinking* views the data warehouse as a support tool to further the qualifying aspect in the organisation, different tools will be compared

according to their ability to enable the business users to apply the analytical aspects of the data warehouse in support of the qualifying aspect of the organisation.

Almost all respondents agreed that end-user requirements need to be collected during the business analysis phase of the data warehouse development lifecycle (question F1). This is in contrast with the methods proposed by Inmon (1996) described in section 4.3.

6.3.4.6 End-user training

From a *soft systems* perspective, the data warehouse is only successful if it is used by the business users. By engaging them in all the development phases, acceptance of the data warehouse by the end-users is established. As stated earlier, the business users involved are only a representative group of between two and four users and not the entire user community. The rest of the users need to be trained to use the data warehouse. It would be ideal if the users that were part of the data warehousing project could do the training of all the other users. The respondents of case study three indicated (as a response to question F6) that end-users need to be trained on neutral data before using the data warehouse data, since they get distracted from the functionality of the end-user tool by organisational information in the data.

Although most respondents reported (question F9) that users do not use the *ad hoc* query capabilities of the tools, follow-up training could rectify this problem.

It is proposed that business users involved in the data warehouse train the other business users and that follow-up training be given after a period of six months of data warehouse usage to ensure business users utilise the data warehouse to its full capacity.

From a *critical systems* approach, business users need to be empowered through training to use the data warehouse to its fullest extent. This view underlines the standpoint taken in the previous paragraph.

Although the *disclosive systems* perspective is similar to that of soft systems thinking presented above, the focus in training would be to enable the users to use the

analytic powers of the data warehouse to understand and further the qualifying aspect of the organisation as a whole.

6.3.5 Management of the system

The management of the system is responsible for setting the objectives of the system, defining the environment, managing the utilisation of resources and dividing the system into components. In data warehouse terms, the management of the system needs to do all of the above, focussed on overall quality assurance and metadata management. The performance of the system should be constantly checked to ensure that the business objectives are achieved.

The management of the data warehousing team should involve all stakeholders in the data warehouse, as depicted in figure 6.6. The group of business users shown in figure 6.6 is a representative group of business users. The data warehousing team comprises people trained in data warehousing and responsible for each of the components discussed in the previous section. This team may include external consultants, provided they share ownership of the organisation's business objectives and therefore of the data warehouse. The respondents of case study three reported advantages of having a small data warehousing team, with team members involved in all phases of the project (question B6). The business sponsor, representative of the executive committee, should be a person highly motivated towards the data warehouse and its success. The source system's owners are technical people from the information systems department concerned with the operational information systems of the organisation.

The data warehousing team should include a project manager responsible for the co-ordination of all activities of the different role players. It is important to select an experienced person who is in touch with the business objectives and familiar with the key problem areas of the organisation.

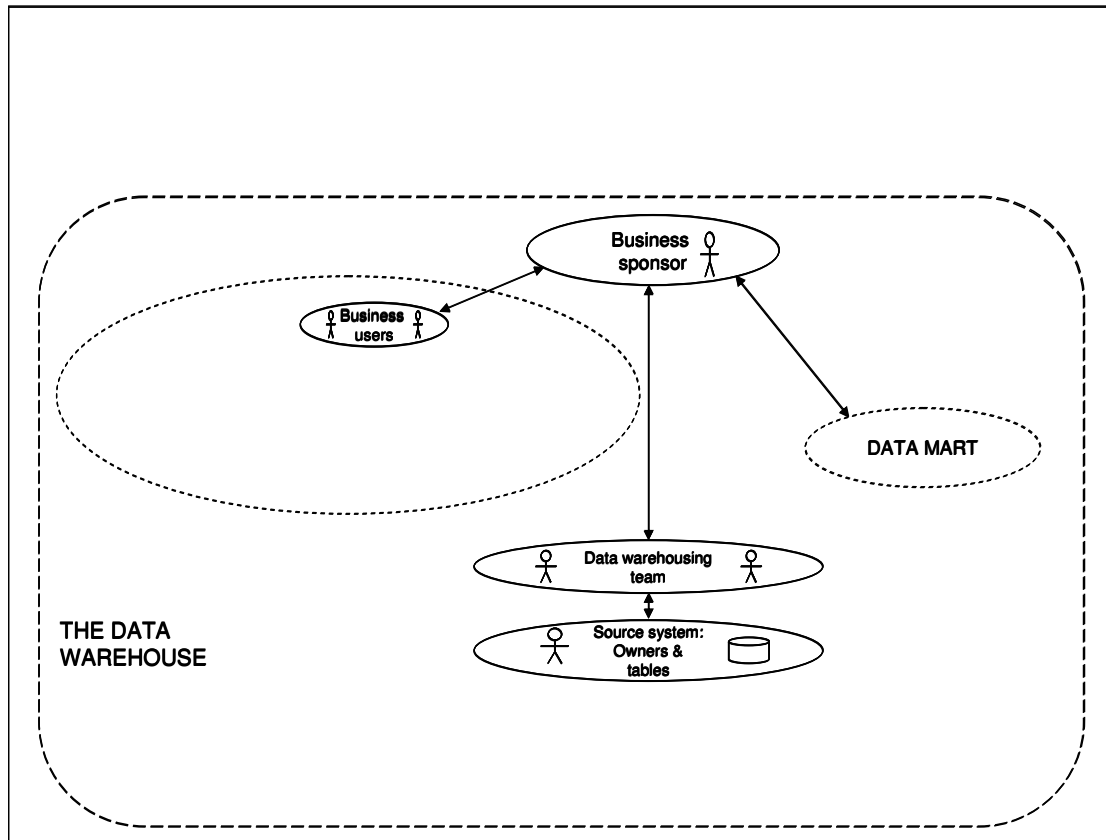


Figure 6.6 *Role players in the data warehouse*

The role players responsible for data integrity should decide on success factors and parameters for determining the success of the data warehouse. Most of the respondents stated that the data warehouse is only successful if it is used to improve decision making (question F12). The project manager along with the other team members should design measures to monitor the usage of the data warehouse. The monitoring team can also identify areas where service could be improved (question F11).

The role players in the data warehouse should decide on different levels of access assigned to end-users. Although the researcher and some of the respondents believe that every user should have full access to all the data in the data warehouse, the majority of the respondents argued that it is not practical and that executive committees want multi-level restrictions on data warehouse access (question F8).

The project leader should ensure a high standard of technical skills relevant to the data warehouse system. This includes a detailed plan for keeping metadata updated

and easily accessible. The project leader and his/her team should also ensure that the overall objectives of the organisation and therefore the data warehouse are taken into account during each activity of the data warehouse system. The respondents in case study three reported that conflict can be eliminated if the responsibilities of all the role players are clearly defined (question B2).

From a *critical systems* perspective, the data warehouse will solve a specific problem and management activities will focus on aspects required to achieve this single objective. The data warehouse team will also focus on the underlying structures of the identified problem. Ulrich's (1987) ideas of "ought to" questions in boundary judgements would be central in the identification of role players in the data warehousing project. The critical systems thinking project leader will be aware of different agendas and motivations and will attempt to expose conflicting views to the main objective of the data warehouse.

From a *disclosive systems* point of view, the project leader will ensure that every role player is assigned definite responsibilities for achieving the intrinsic normativity of the organisation. The ethical values of the data warehouse team will also be defined clearly, and the project leader will hold them responsible for adhering to these.

6.3.6 The relationships between the components and role players in the system

Figure 6.7 contains the complete framework with numbers assigned to each of the connecting lines. The meaning of each line is described briefly in table 6.1, thereby completing the discussion on the framework. The explanations of the various connections contained in table 6.1 are applicable to all the discussed systems thinking methodologies^{1&2} unless otherwise indicated.

7	Business users are involved in the feasibility study.
8	Business users are involved in the modelling of the data in terms of star schemas.
9	Business users are involved in data staging.
10	Business users are involved in the selection and implementation of end-user tools.
11	Business users are involved in end-user training.
12	Business users are in frequent contact with the business sponsor and vice versa.
13	Data warehousing team members are in frequent contact with the business sponsor and vice versa.
14	Data warehousing team members are in frequent contact with the source systems owners and vice versa. Data quality and availability issues are frequently discussed.
15	Source system owners are involved in the data staging process supplying data, but also accepting improved data or additional data resulting from data mining efforts.
16	Conformed dimension tables are updated as a result of data staging. It is however possible to send updated table data back through the staging area to the source tables.
17	The design of a data mart influences the group of conformed dimension tables in that tables are added or changed. Current dimension tables could also influence the design of a specific data mart.
18	The data warehousing team is involved in end-user training.
19	The data warehousing team is involved in end-user tool selection.
20	The data warehousing team is involved in data modelling.
21	The data warehousing team is involved in the feasibility study.
22	The data warehousing team is involved in business analysis.
23	The source system owner assists in the feasibility study; it is also possible that data capturing standards in the source system changes as a result of the feasibility study.

Table 6-1 An explanation of the connections on the framework

6.4 Comparison of the framework with existing models

The framework presented in this chapter differs from the models presented by Wixom and Watson (2001:17) and Kimball *et al.* (1998:329). The main differences are highlighted in this section.

6.4.1 The framework compared to the Wixom and Watson (2001) model

The model presented by Wixom and Watson (2001: 20) is repeated in figure 6.8 to aid explanation. This model was proposed by Wixom and Watson (2001) as a basis for data warehousing research and not explicitly as a model for data warehousing methods. It does however indicate a perspective of role players in the data warehouse development activity.

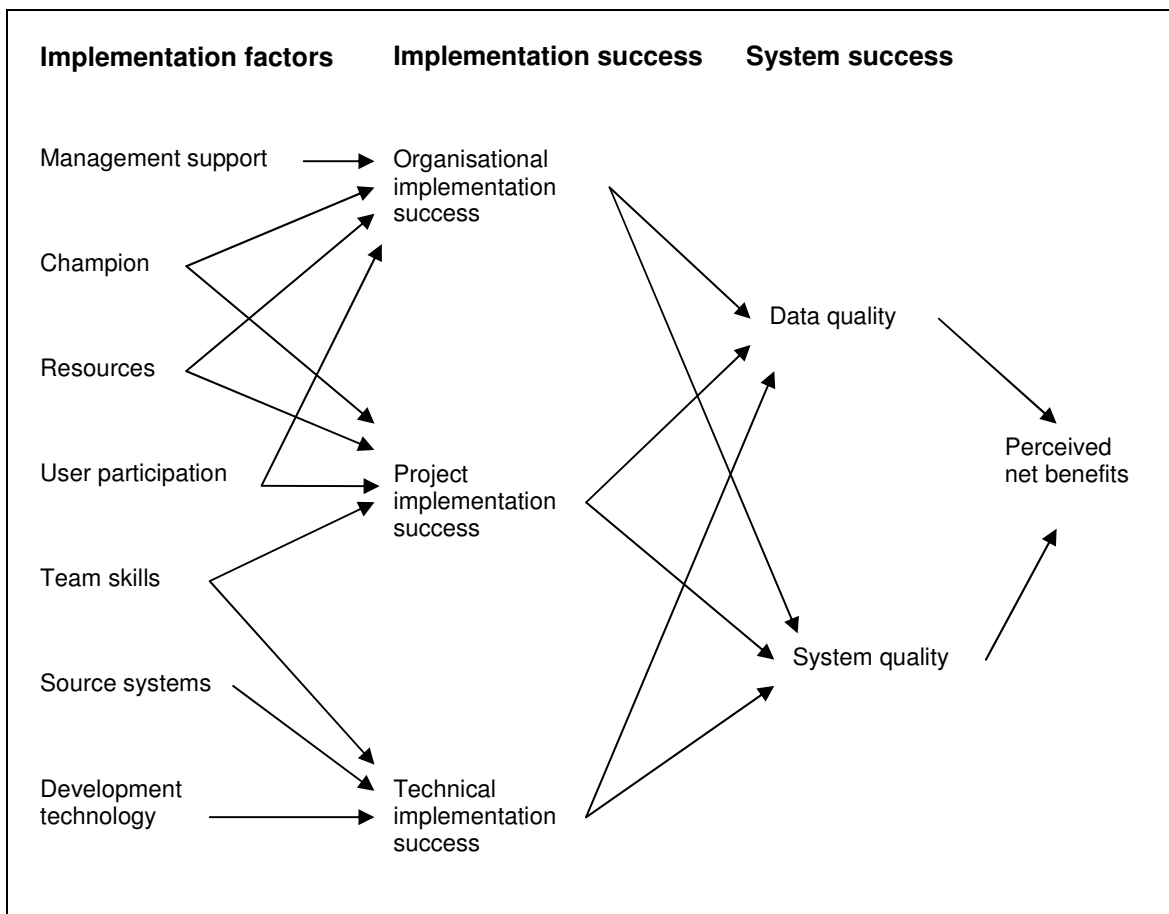


Figure 6.8 The data warehouse research model of Wixom and Watson (2001:20)

The following differences are evident when comparing the Wixom and Watson model (2001) with the framework presented in this chapter:

- In the Wixom and Watson model, management support does not extend to project and technical success. Even if the “champion” is part of the management team, he/she is not involved in the technical success of the project. In the framework presented in this chapter, the business sponsor (representing management support) and the business users are involved in everything related to the data warehousing team’s activities. Both the data warehousing team and the business users have direct access to the business sponsor.
- From the Wixom and Watson model, it is not clear why resources do not extend to technical implementation success.
- Wixom and Watson do not indicate the influence of the organisation’s objectives on the process.
- According to Wixom and Watson, the users are not involved in technical implementation success.

6.4.2 The framework compared to the model of Kimball et al. (1998)

Kimball *et al.* (1998) played an influential role in the researcher’s view of data warehousing practices. Kimball *et al.* (1998) can be viewed as a soft systems response to the hard systems approach introduced by Inmon (1996). They do not link their data warehouse views to any methodological₁ viewpoint, nor do they provide a single illustrated framework indicating the role players in the data warehouse system. They also do not explicitly involve the users in the data warehousing team but do advocate user participation in data modelling when stating that users are able to understand star schemas.

Kimball *et al.* (1998) use two illustrations to indicate the data warehousing process and the technical data warehouse architecture (refer to figure 4.3 and figure 4.1 respectively). Neither the organisation’s objectives nor data warehouse role players are included in either of these illustrations. When studying the complete monograph, it is clear that Kimball *et al.* (1998) advocate similar role players to those indicated in the framework presented in this chapter.

Another important difference to the work of Kimball *et al.* (1998) is the participation of users in technical phases, such as data staging. Kimball and co-authors do not include a business user on the data warehousing team, nor do they refer to any contact with end-users during data staging.

In conclusion, Kimball *et al.* (1998) display some evidence of using soft systems ideas in data warehousing practices, but do not follow an explicit soft systems approach, where role players, worldviews, objectives and management are identified explicitly. These notions of soft systems thinking were part of the initial motivation of the researcher to make explicit the link between data warehousing practices and systems thinking methodologies_{1&2}.

6.5 Summary

The aim of this thesis was to develop a framework for the explicit use of specific systems methodologies₁ in data-driven decision support system development practices. Data warehousing was chosen to represent data-driven decision support systems.

The research was done according to a pluralistic approach of combining interpretive and critical social research practices. The combination of different research practices was based on a study of research philosophy, methodology₁ and practices in general, as well as applied to information systems research specifically.

The concluding framework presented in this chapter is a combination of information gained from literature studies and interpretive case studies. The framework presented here is not, as in pure interpretive research, a theory describing current practices of data warehousing practices. It should rather be viewed as a framework to guide the practices of data warehousing professionals. This view represents the critical research or intervention aspect of the research.

The literature study presented in chapter 3 gave a discussion on systems in terms of philosophy, methodology₁, and practice. This philosophy-based approach was required since systems thinkers do not give guidance to data warehousing practitioners, and the researcher had to understand the philosophical foundation of

systems methodologies_{1&2} before applying specific systems thinking methodologies₁ to data warehousing.

Another source of information was data warehousing literature. A literature study on data warehousing and data warehousing success factors was presented in chapter 4.

The researcher required practical information about current data warehousing practices to gain understanding of the role systems thinking can play to improve data warehousing success. Three interpretive case studies were conducted to collect data on current data warehousing practices. Pattern-matching was used to analyse the collected data according to systems thinking methodologies_{1&2}. The analysis indicated that, although the first organisation followed mainly a hard systems thinking approach, they were able to express soft ideals. The second organisation followed a soft systems thinking approach to some extent, but not all data warehouse team members bought into the organisation's objectives as a motivational factor for their activities. The third organisation, being a consulting firm, reported mainly on ideal practices. They supplied information on how they believe data warehousing practices should be performed to be successful. Aspects of critical systems thinking were clearly evident from their soft system thinking answers. They gave very few hard systems thinking answers. The researcher concluded that hard systems thinking is not advantageous to data warehousing practices.

The combination of literature studies and case study data lead to the development of a framework for the explicit use of specific systems thinking methodologies_{1&2} in data warehousing practices. The framework presented in this chapter focussed mainly on a soft systems approach but can easily be extended to include critical and disclosive systems thinking perspectives.

The framework was discussed with the people who participated in the case studies. They were satisfied that the framework proposed practical solutions that may lead to increased data warehousing success in organisations. The manager of the data warehousing department of case study one's organisation identified three benefits of this research initiative:

- Table 5.5 indicated that the manager is more inclined towards soft systems thinking than the other team members. Based on the insights into the motivation of individual team members provided by table 5.5, the manager is able to identify specific problem areas.

- The completed framework serves as a communication tool to explain the role of the data warehouse in the organisation to top management, and to motivate top management to allocated organisational resources to the data warehouse.
- The framework will be used to illustrate the holistic nature of the data warehouse as a system to the data warehousing team members.

6.6 Further research

The researcher aims to test the acceptance of the framework in industry to complete the intervention aspect of the research. More organisations will be targeted, as well as industry literature, popular web sites and data warehousing periodicals.

This application of disclosive systems thinking can be extended to other problem situations to assist in the development of a general methodology₂ for the application of the disclosive systems thinking methodology₁.

The thesis concludes with an evaluation of the research that produced the framework presented in this chapter.

6.7 Evaluation

As a conclusion to the thesis, the research is evaluated according to the following criteria for evaluating a theory for scientific progress as proposed by Introna (1992:5.31):

- a. Does the theory raise problems previously not perceived, e.g. problems of an increasing depth, and does it display an ever-increasing fertility in new problems?**

This research highlights the relationship between philosophy, methodology₁, and practices. It applies knowledge gained by the exploration of these relationships to data warehousing practices. The study opens up research into the application of these relationships in other information systems disciplines. It also furthers the development of specific systems thinking methodologies₂, specifically disclosive systems thinking.

b. Does the theory anticipate novel facts and auxiliary theories?

A new way of addressing problems in information system development is proposed. Problems are to be addressed from a philosophy, methodology₂, and practice framework. This perspective may lead to an increased awareness of the advantages of systems thinking and different systems thinking methodologies_{1&2} in information systems development. Other researchers may also explore the direct relationship between philosophy and information systems development practices.

c. Is the theory more precise in its assertions and in the facts it explains than previous theories?

From a data warehousing perspective, the answer to this question is in the affirmative. The proposed framework for data warehousing success differs from existing frameworks in that it provides a solid philosophical and methodological₁ foundation. Other existing frameworks only base data warehousing success on past experience, i.e. the practice level of the philosophy, methodology₁, and practice model.

d. Has the theory unified or connected various hitherto unrelated problems, or concepts?

Although hard, soft, and critical systems thinking methodologies_{1&2} have been linked to information systems development, they have not been linked to data warehouse development methods before. Disclosive systems thinking has not been linked to any information systems development methods prior to this study.

e. Does the theory have positive and negative heuristic power?

Introna (1992:1.118) states: "Positive heuristic power indicates which research paths should be pursued and negative heuristic power indicates which research paths should be avoided. Without heuristic power, a research program would collapse into *ad hoc*-ness."

Chapter 2 explored different perspectives of the problem situation as reported in this thesis. From a negative heuristic power point of view, it was indicated that the research problem did not purely fit into either interpretive or critical research methodology. From a positive heuristic power perspective, it was

indicated that a pluralistic approach using case studies, pattern matching, and intervention, can produce a scientifically sound solution to the problem.

This solution can be extended to other research problems of a similar nature. One may generalise the research problem as a problem where the respondents in the problem situation are not familiar with the aspects under investigation. Chapter 2 raised two similar research problems, namely a study of adjustment problems in children and a study on the extent to which parents use pedagogical principles unknowingly in the upbringing of their children.

f. Has the theory produced a new perspective on existing problems and thus created a new understanding of these existing problems?

This study produced a systems thinking perspective on data warehouse development methods. Failure of data warehousing projects can now be understood from a holistic point of view. The work of Kimball *et al.* (1998) is now viewed from a soft systems perspective, whereas previously, it was viewed only from a data warehouse industry point of view.

g. Has the theory produced unconventional ideas, ideas that radically challenge current conceptions?

The answer is in the affirmative. Data warehousing professionals did not previously seek solutions to their problems in philosophical ideas. Any model that links philosophy and methodology₁ to data warehousing practice is foreign to the data warehouse practitioner. An in-depth literature search did not yield any literature exploring relationships as presented in this thesis.

The use of pattern matching as performed in chapter 5 is also unconventional in information systems research. Although it is difficult to search extensively for similar applications, none were found.

From the above evaluation, it is clear that the research presented in this thesis satisfies the criteria laid down by Introna (1992) and therefore represents scientific progress.

6.8 Research conclusion

The aim of the research was to develop a framework for the specific use of systems thinking methodologies_{1&2} in data warehousing practices. This research objective was divided into sub-objectives in chapter 1 (section 1.4). In order to reach the first sub-objective, namely to understand data warehousing practices from a systems thinking point of view, literature studies were conducted on systems thinking and data warehousing. The aim of the case studies was to explore the systems thinking nature of current data warehousing practices. Analysis of the case study data indicated that most data warehousing practices in the organisations studied can be related to soft systems thinking. There were practices that could be related to hard systems thinking, but management expressed dissatisfaction with these. Some practices on the other hand could be related to critical systems thinking. The case study data also indicated that respondents might have preferred practices related to critical or disclosive systems thinking, had they been knowledgeable regarding these methodologies_{1&2}. This perception will be tested in a follow-up study. Although very few disclosive systems answers were given, managers in case study two reported that patient care should be important in all their actions.

In reaching the second objective a framework was developed for the use of specific systems thinking methodologies_{1&2} in data warehousing practices. The framework was depicted on a single figure that was viewed through three different lenses for soft, critical, and disclosive systems respectively.

The researcher repeatedly came to the conclusion that to evaluate the motivation of the practitioner for preferring certain practices, one needs to understand the methodological₁ and philosophical underpinning of such practices.

It also became clear that different systems thinking methodological_{1&2} viewpoints may lead to similar practices, although the underlying motivation for these practices is based on different ontological (philosophical) views.