

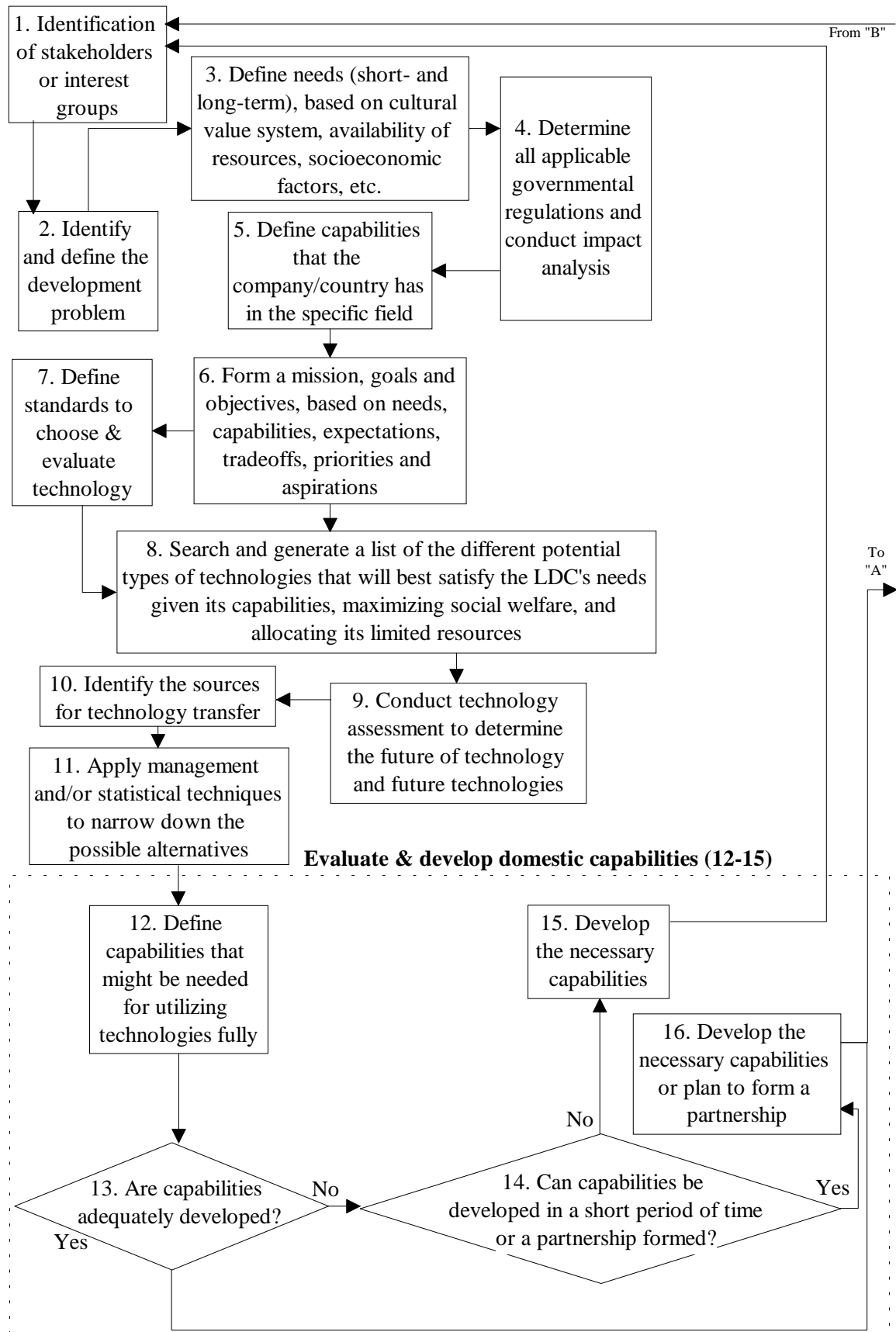
#### **4. A Model for Telecommunication Technology Transfer/Diffusion into Rural Areas of South Africa**

Technology transfer is a complex process that, if not managed wisely, can become a burden on national development. When transferring technology from one country/company to another, at different levels of technological know-how, the process holds many problems that need to be overcome.

The telecommunication industry is a high-tech fast moving field with ongoing technology transfers taking place. Problems do exist and a solution is needed to plan proactively for future technology transfers. If not planned systematically the transfer process can lead to unsuccessful allocation of resources.

The Model for Telecommunication Technology Transfer/Diffusion into Rural Areas of South Africa forms the core of this dissertation. This chapter provides the telecommunications industry with systematic guidelines (model) for technology transfers, which includes both parties (source and receiver). The situation in South Africa will also be discussed on the basis of the transfer model in Chapter 5.

The model is divided into two parts shown in Figure 4.1 and Figure 4.2. The interaction between Figure 4.1 and Figure 4.2 is shown through the lines: *To "A"*, *From "A"*, *To "B"*, and *From "B"*. The sub-elements of both figures will be described below. The reason for the division is purely because of paper size and no official technical meaning was attached to the separation.



AHP = Analytic Hierarchical Process

**Figure 4.1. Model for Telecommunication Technology Transfer/Diffusion into Rural Areas of South Africa (Part I)**

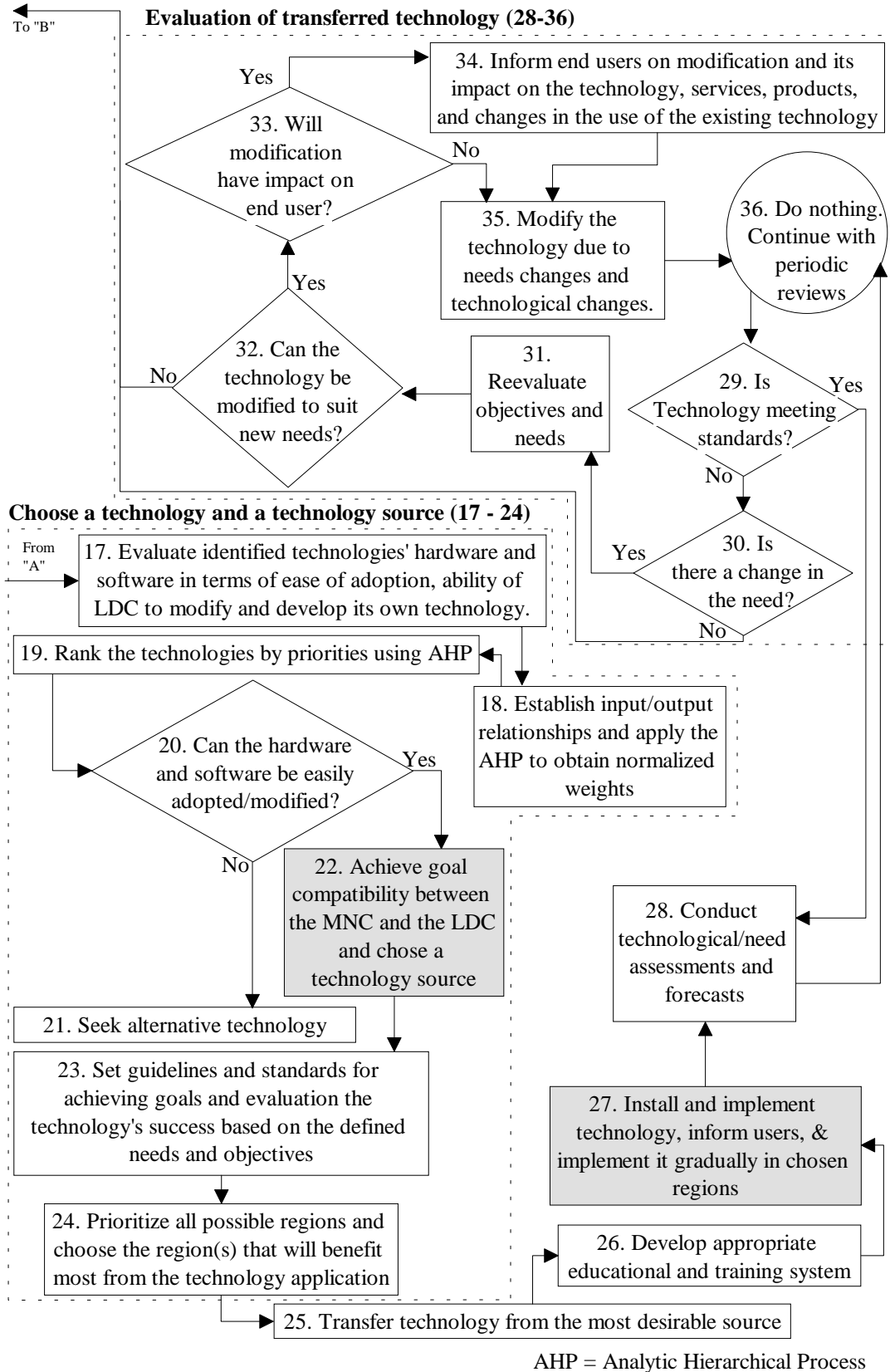


Figure 4.2. Model for Telecommunication Technology Transfer/Diffusion into Rural Areas of South Africa (Part II)

#### **4.1. Identification of Stakeholders or Interest Groups (1)**

The policy maker identifies the stakeholders or interest groups whose actions may influence, or who are influenced by, the technology transfer process. A team is then formed evaluating and recommending the policy maker the appropriate technology to transfer. The team of stakeholders consists of people such as:

- People directly involved in the technology implementation,
- People involved in adaptation and modification,
- Corporate personnel of the receiving telecommunication firm,
- Corporate personnel from the technology supporting and supplying,
- The end users, and
- The Governmental regulator.

The *active* participants identified by the policy maker forms the stakeholders. If their participation is actively integrated into the decision-making process, the implementation of technological decisions reached by the team will be enhanced.

It is also important to identify the stakeholders' views and their cultural values. One needs to determine these values and viewpoints because they will definitely have an impact on the transfer process. The difficult part however is to integrate these aspects into the decision-making process.

It is extremely important to view the end users as stakeholders and to incorporate their ideas and needs into the transfer of technology. One of the biggest mistakes made is to only conduct a market research and then to believe that all useful inputs are accounted for. It is however still of importance to know as much as possible about the end user's preferences and to draw up a profile. To know your customer is a cardinal key to client satisfaction in the service industry.

#### **4.2. Identify and Define the Development Problem (2)**

Each country/company is unique in a sense and therefore the development problem, while many similarities might exist, will also be unique in many ways. The development problem definition is a clear outlay of all the factors/problems that limit the overall growth or development of the involved country/company. To be able to identify the right development problem the stakeholders need to have vision and must be comfortable with the local conditions. One must be extremely careful when using outsiders during this process. They are often unrealistically expensive and not always in tact with the country/company's situation.

The use of foreign consultants are only advised when the country/company's personnel does not have sufficient capabilities, and then it must be done in collaboration with local stakeholders which will still allow them to give their inputs.

#### **4.3. Define Needs (Short- and Long-term), Based on Cultural Value System, Availability of Resources, Socio-Economic Factors, etc. (3)**

In this phase of the technology transfer model the LDC needs to set up most of the modified relevance tree diagram (MRTD) (discussed earlier). The standards included in the MRTD are defined later in the transfer model. Setting up a MRTD forces the stakeholders to define an overall company goal, mission, and the purpose or reason for existence. When the LDC's objectives, strengths, and weaknesses (constraints or limitations) are clearly defined the stakeholders can make decisions, recommendations, and analysis based on the right foundation. These objectives are then used to establish standards for achieving the desired outcome. The needs of a country can be determined using the Need-Capability Matrix as discussed in Chapter 3.

A sufficient quantity of information is available in the literature on the subject of determining needs using the Needs- Capability Matrix. The method was not repeatedly described here because the author feels the topic was thoroughly covered during the literature study (3.3.1.1, Chapter 3). The reader is therefore referred to Chapter 3 for more in-depth information concerning this topic.

#### **4.4. Determine All Applicable Governmental Regulations and Conduct an Impact Analysis (4)**

The telecommunication industry plays a very important role in the provision of the infrastructure needed for national development. The government therefore have a certain regulatory function to fulfil. Through regulations Icasa delimits the borders of the telecommunications playfield. The task of the regulator is however to steer the industry in the right direction and not to set unrealistic goals and expectations. Section 2 of the 1996 Telecommunications Act is a tool with the primary object to provide regulation and control of telecommunication matters in the public interest. If not wisely managed, the regulations can be a burden on the industry and limit the technology utilisation. The regulator should therefore have the latest news available and should do periodic evaluations on the impact of the regulations on the industry. Only then can Icasa have a positive influence on the industry.

This influence from the regulator on the industry can be noticed when observing the fixed line telecommunication industry of South Africa. The situation will now briefly be discussed:

#### **4.5. Define Capabilities That the Company/Country has in the Specific Field (5)**

The ability to receive a transferred technology depends on certain capabilities that need to be vested within the country/company. Focussing on ones capabilities and strengths is a recipe for success. A country must use its competitive advantage while still not neglecting its weaknesses and limitations. The Need-Capability Assessment Matrix is a useful tool for making technology decisions based on defined capabilities

#### **4.6. Form a Mission, Goals and Objectives, Based on Needs, Capabilities, Expectations, Tradeoffs, Priorities and Aspirations (6)**

Once a country knows its needs, capabilities, strengths, weaknesses, and limitations, it can form goals and objectives to solve the defined development problem. Only the local stakeholders can truly assess the expectations and aspirations of the people. There will always be tradeoffs between different alternatives and goals, which should also be defined clearly. Once the objectives are well defined and all limitations and capabilities well understood set criteria could be established to achieve these objectives.

#### **4.7. Define Standards to Choose & Evaluate Technology (7)**

Once the technology is in place and operational its success must be evaluated continuously. The standards on which one chooses a specific technology are derived from the needs and capabilities determined earlier in the transfer model. These standards are also included in the modified relevance tree diagram (MRTD).

#### **4.8. Search And Generate A List Of The Different Potential Types Of Technologies That Will Best Satisfy The LDC's Needs Given Its Capabilities, Maximizing Social Welfare, And Allocating Its Limited Resources (8)**

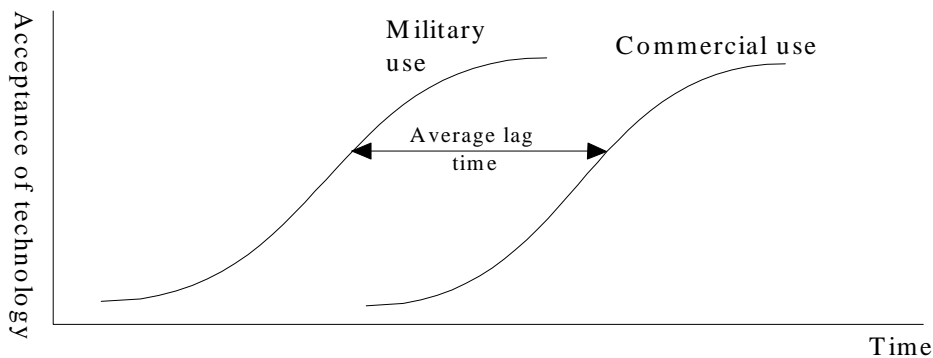
Because of the fast moving technological nature of the telecommunications industry many alternatives will often be possible, which could fulfil the need of LDCs and help them in reaching their goals. As each technology poses different constraints, the focus of this block in the transfer model should be on identifying as many alternatives possible. The more alternatives one have, the better decision can be made on choosing the most appropriate technology for the specific country's situation. When generating the list of alternatives a country should only identify technologies and try not to evaluate them in the same exercise. The decision on which technology to transfer will be dealt with at a later stage in the technology transfer model when most of the deterministic factors are known.

#### **4.9. Conduct Technology Assessment To Determine The Future Of Technology And Future Technologies (9)**

Conducting technology assessment to determine the future of technology and future technologies is a difficult task, which requires experience. Many LDCs with limited experience make use of foreign consultants to fulfil this function. Several authors [44] have presented useful techniques, such as technological progress functions (S-curves), trend extrapolation, the Delphi method, and scenario development.

One way of forecasting technology is to determine the technology being applied in military applications. In this method of forecasting, the user determines the average lag time for technology to be diffused from a military application into commercial markets. One assumes then this calculated average lag-time and uses it to predict the future technologies. In Figure 4.3 the acceptance and urge to apply the technology is shown on the vertical axis. Time is given on the horizontal axis with contours of the two application positions (military and commercial markets) shown. The lag time is then the average time a technology takes to be accepted into the commercial market from the point in time the same acceptance was experienced in the military. This is however a very rough estimation but technology forecast is a topic on its own that needs much more attention, which was

not intended with this dissertation. The reader is referred to Wheelwright and Makridakis [44] for further information on the topic.



**Figure 4.3. Technology diffusion from military application into commercial market**

#### **4.10. Identification Of The Sources For Technology Transfer (10)**

This block of the technology transfer model guides the receiver to again consider all alternative technology sources. One should be careful to build up a business relationship with only one technology provider and not to consider other alternative sources for technology. The decision on the specific technology source will be done later in the process.

#### **4.11. Apply Management and/or Statistical Techniques To Narrow Down the Possible Alternatives (11)**

Once the lists of alternative technologies and technology sources are generated the possibilities are often very resource intensive when evaluating all individually. Systematic approaches can then be applied and statistical techniques used to narrow down the list.

#### **4.12. Evaluate and Develop Domestic Capabilities Needed for Technology Utilization (12-16)**

Any technology needs support. Whether in the form of energy provision, information management, maintenance, expansion, adoption, or supplying needed inputs, it plays a very important role in determining to what extent the technology can be utilized. The LDC should evaluate its ability to fulfil these supportive tasks and plan accordingly.

Cross-hierarchical communication between corporate and executive management must occur. Technology space maps, also known as S-L-H-Maps (Space, Lifecycle, and Hierarchical map), is a tool used to communicate complex technical concepts in a simple manner to corporate (financial) managers. This tool is also very useful for a country/company to determine their capabilities, needs, and weaknesses. A brief description of the Technology space map and its application in the technological need determination will be given below.

A technology space map is a collection of two-dimensional matrixes, one for each component of the "Technology Triangle" (people, tools, and knowledge). This collection of two-dimensional matrixes form a three dimensional cube. For clear and simpler

representation two-dimensional S-L-H-Maps are used. An example of a S-L-H-Map is given in Figure 4.4.

	Research	Design	Development	Produce	Maintain	Use
User system						
Product system						
Product		New technology considered for transfer				
Subsystem						
Component						
Material						

**Figure 4.4. Transferred technology’s planned utilization area on a S-L-H-Map (Space Map)**

On the horizontal axes the system life cycle is subdivided into subdivisions. The Vertical axes indicate the system hierarchy. Through evaluation of the technology in each hierarchical level and in each phase of its life cycle, the LDC should plan and identify the utilization capabilities and plot them on the S-L-H-Map. In order to determine the needed supports that must be vested within a country to enable them to fully utilize the new technology, they should first position their planned utilization area on the space-map.

The LDC must be able to support the transferred technology on two sides namely the positions exactly to the left and to the bottom of the technology. These areas can be identified as a class 1 and a class 2 support for the new technology respectively as indicated in Figure 4.5. The Class 1 support is a support that the technology needs earlier in the life cycle phases in the same hierarchical level as the one in which the company is planning on utilizing it. This support can be in any component of the “technology triangle” (described in Appendix A of the technology transfer model). A class 2 support is a supplier on lower hierarchical levels at the same phase in the life cycle.

	Research	Design	Development	Produce	Maintain	Use
User system						
Product system		Class 1 opportunity				
Product		Class 1 support for technology	New technology considered for transfer		Class 2 opportunity	
Subsystem						
Component			Class 2 support for technology			
Material						

**Figure 4.5. Transferred Technology’s needs and opportunities on a S-L-H-Map (Space Map)**



The LDC should identify limitations on aspects that the country have insufficient capabilities and develop them if possible in a reasonable time span. If not possible a capability development plan should be generated and followed before the country/company is ready to participate in technology transfers, or the LDC will only become increasingly dependant on MNCs. If most of the needs, but not all, can be fulfilled by the LDC it should seek for a partner to supply the support infrastructure.

The new technology can in its turn enable the company to operate as a support to other technologies/firms in two ways. The customer can be a class 1 client where the transferred technology will be appearing in the position of a class 2 supporting unit, or the client can be of class 2 in which case action will be conducted as a class 1 supporting unit. The class 1 and class 2 clients are opportunities for the receiving company (LDC) in the technology transfer process when exploiting the transferred technology. Caution must however be taken to prevent these opportunities to make the LDC too enthusiastic and optimistic. Neglecting the shortcomings in fulfilling the needed support functions for the new technology is a vital mistake, which is often made.

#### **4.13. Choose a Technology And a Technology Source (17 - 24)**

##### **4.13.1. Evaluate Identified Technologies' Hardware And Software in Terms of Ease of Adoption, Ability of LDC to Modify and Develop Its Own Technology (17)**

As the LDCs embark on a mission to transfer and develop technology, the humanistic and behavioural aspects of such decisions need to be evaluated. There may be different types of technologies able to satisfy aspects such as ease of adoption and ability of LDC to modify and develop its own technology. They should be evaluated and decisions made based on how well a particular technology is able to satisfy these criteria. In the case of technology transfer to LDCs they should evaluate the possible technologies carefully to find an appropriate technology. The focus should be on a search for technology that will best satisfy needs, maximise social welfare, allocate limited resources wisely, and do all of this whilst minimising the LDC's dependency on the MNC. Essentially, technology transfer to LDCs should be evaluated on its long-term merits by both the transferor and the transferee.

Quality of technology should also be evaluated not solely on the basis of finished products and services but also on the environmental impact [7] and its ability to satisfy the mission of the LDCs.

##### **4.13.2. Establish Input/Output Relationships and Apply the AHP to Obtain Normalized Weights (18)**

Technologies are always dependant on other supportive technologies and have an interfacing relationship with other technologies on the same level of the technological hierarchy. It is necessary to establish the input-output relationships between different technologies since resources cannot be allocated in terms of priority when interdependence exists. This can be done through the use of an input-output-matrix as discussed in the section: "How to transfer technology".

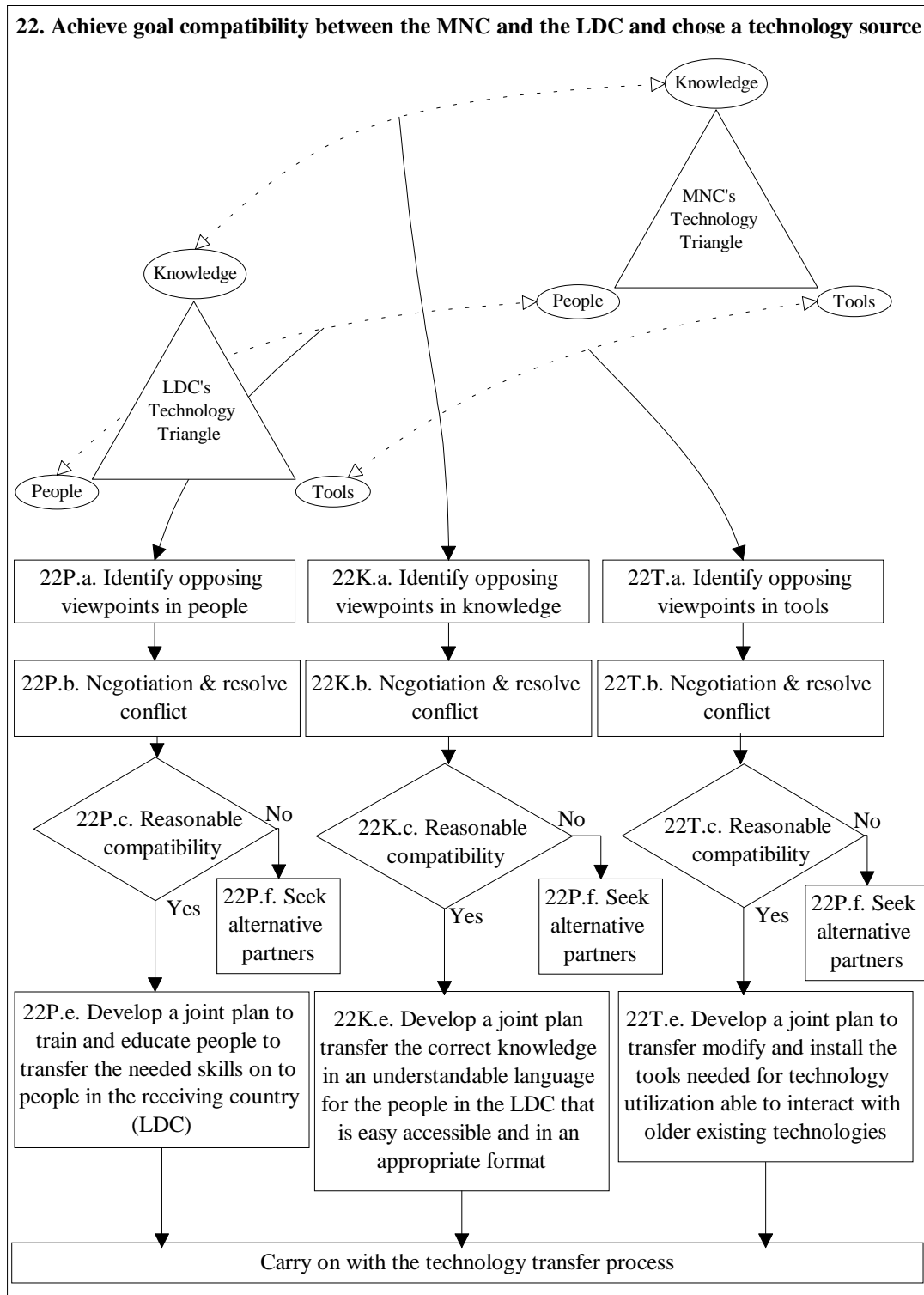
#### **4.13.3. Rank Technologies by Priorities Using AHP (19-21)**

A transferred technology should offer opportunities to the LDC to create a sustainable growth culture and should not make the LDC dependant on the MNC. The new technology will always have different properties compared to earlier existing ones. Skills must be developed within the LDC to adapt technology to local conditions and modify/adopt the hardware and software. If this aspect is not easily achievable the LDC should seek for an alternative technology. The local technicians can also play a role in the adaptation process through the setting of all technical specifications to MNC. This can also enable all interfaces with older technologies to function properly.

#### **4.13.4. Achieve Goal Compatibility Between MNC and LDC and Choose a Technology Source (22)**

In order to transfer technology successfully between two parties that differ on aspects such as technological capability, need, aspiration, and expectation (as is the case with technology transfer between a MNC and a LDC), both parties need to acknowledge and understand the differences between them and plan accordingly. In order to clearly identify all differences one firstly needs to have another look at the basic definition of technology and evaluate the two situations on the basis thereof (see Appendix A).

The characteristics between the LDC and the MNC of all three components of the technology triangle differ for a specific technology (see Figure 4.6). In order for a technology to be transferred effectively the provider (source) and receiver must be well aware of these differences. The countries will definitely differ for each component when a technology is transferred from a developed country (MNC) to a less developed country (LDC). The focus of this block in the technology transfer model is on all three aspects of the technology triangle. This is indicated in Figure 4.6.



**Figure 4.6. Achieve goal compatibility between the MNC and the LDC and choose a technology source**

Opposing viewpoints between the objectives of the supplier and the receiver on all three technology components must be identified. The conflicting aspects should be negotiated until there is reasonable compatibility. Without this stage being reached the technology should not be transferred from the specific provider (source) and if this stage cannot be

reached an alternative supplier must be considered. A joint plan should then be developed for each component in the technology triangle in order to make the transfer of appropriate technology possible and viable for both parties.

### ***The Joint Plan***

The joint plan should include three aspects. These are:

- A training and educational program for the LDC's people. The MNC have a responsibility towards the LDC to transfer the needed skills that will enable the LDC to utilise the technology fully.
- The transfer of the correct knowledge in an understandable language, easy accessible, and in an appropriate format for the people in the LDC.
- Modification and installation plans for the needed tools in the technology utilization. It is extremely important to be able to integrate this new technology with older existing ones.

#### **4.13.5. Set Guidelines & Standards for Achieving Goals and Evaluating the Technology's Success Based on Defined Needs and Objectives (23)**

Setting standards should be done carefully and in conjunction with the goals, mission, and objectives defined. These standards are necessary to ensure that the desired goals and objectives of the LDC are continually being satisfied. If the standards are wrongly defined the stakeholders will have difficulty evaluating them on the basis of reaching their goals or advancing in the right direction.

Both the stated objectives as well as the standards should be continually re-evaluated. The original standards may not be appropriate if there comes a change in the needs/objectives. The focus should be on setting standards verifiable to measure the success or failure of the technology transfer process. Guidelines and standards are a control measure for assessing the success of the technology.

#### **4.13.6. Prioritise All Possible Regions and Choose the Region(s) Which Will Benefit Most From the Technology Application (24, 25)**

The borders of the telecommunications playfield are delimited through Icasa regulations. The Telecommunications Act's objectives are to provide telecommunication in the public interest. With new transferred technologies, the success and overall advantage to the public might depend to a large extent on the parameters of the rural community in which the technology will be utilised. The policy maker should therefore acquire updated information on the user's profile through research and market surveys. One mistake that is often made is to outsource this task and not to be involved in it at all. The market survey can be outsourced effectively only if the policy maker plays an active role and are involved continuously. This exercise should be done on a periodic basis and evaluations made on the impact of new technologies on the community.

The author found, as explained in the research postulate, that this is another phase in which the South African telecommunication companies seems to be failing.

Once the regions are identified and prioritised the technology can be transferred from the most desirable source. Considerable attention should be given to joint plans developed in block 22 of the technology transfer model, and the focus steered on transferring all three technology-definition-aspects accordingly.

#### **4.14. Develop Appropriate Educational and Training Systems (26)**

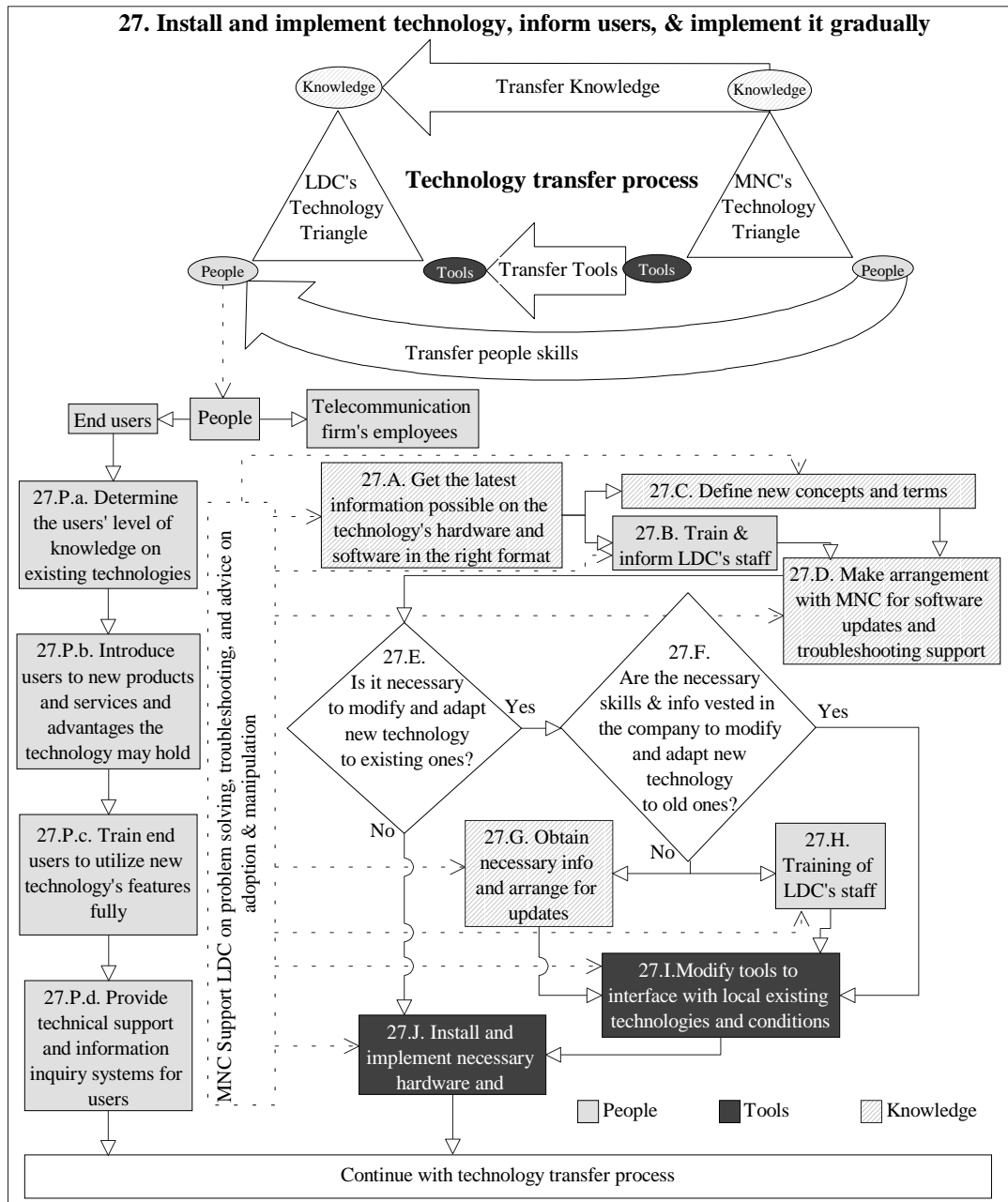
Education plays a vital role in the utilisation success of telecommunication technologies. Educational policies need to be tailored to meet requirements of technology acquisition, adaptation, and development. With effective training and educational systems, the LDCs are better able to improve and modify technology to suit their needs [7]. In the absence of appropriate educational systems, LDCs will continue to be largely dependant on the transferor to supply the right labour force, to carry on technological innovations, and to engage in research and development [7].

Poor education and training limit socio-economic growth. The educational and training programs must however be focused on addressing needs and problems of a LDC, and how these may be solved through technology. Programs like on-the-job training, in-house training, seminars, and tuition reimbursements plans are often carried out to keep the workers abreast of technological changes.

A joint plan between transferor and transferee should include education and training of the local work force. Change can only be managed through appropriate education, training, and awareness development programs. The appropriate educational programs are furthermore needed to create an effective pool of managers.

**4.15. Install and Implement Technology, Inform users, & Implement It Gradually (27)**

Another problem that cannot be neglected is the one expected in the research postulate where the rural communities are not always adequately informed about the use of and advantages that the technology holds. Considerable time and resources should be allocated towards solving this problem.



**Figure 4.7. Install and implement technology, inform users, & implement it gradually**

Informing rural communities can be done through a systematic four step approach (see Figure 4.7 left column) involving:

- Determine the users' level of knowledge on existing technologies (27.P.a.)
- Introduce users to new products, services and advantages the technology may hold (27.P.b.)
- Train end users to utilize new technology's features fully (27.P.c.)
- Provide technical support and information inquiry systems for users (27.P.d.)

Installing and implementing the technology is another crucial block in the technology transfer model, which include sub-procedures of informing end-users and implementing the technology gradually. This sub-process is once again related to the three elements of the “technology triangle” and the filling effects used in the blocks shows the distinction as indicated at the right lower corner of Figure 4.7.

One should obtain the latest information possible on the technology's hardware and software. This should be in an appropriate language and in the right format (17.A.). The MNC should be involved in the training and informing process of the LDC's staff (27.B.). The better the level of the LDC's personnel's knowledge on the new technology, the better the chances are that the LDC would be able to modify the technology to interface with local conditions and existing technologies and even to develop or improve technologies in the future. This is a very important aspect in determining the ability of the LDC to become independent of MNCs. The local staff should be familiar with new concepts and terms (27.C.) before they would be able to communicate effectively with the MNC.

The LDC should further arrange with the MNC (27.D.) on obtaining software updates and troubleshooting support. This will enable maximum utilisation and facilitate future adaptation of new technologies to interface with the current transferred technology. The question that needs answering is whether the new technology needs to be modified and adapted to existing ones and to what extent this should be done (27.E.). The next step should be to obtain necessary skills, and then to adapt/modify the information of this new technology (27.F, 27.G, 27.H.). This brings the process to a point where tools are modified to interface with local existing technologies and conditions (27.I.) actually being installed and implemented (27.J.)

#### **4.16. Conduct Technological/Need Assessments and Forecasts (28)**

An important element in the technology transfer process is the capability to perform systematic technological forecasting. Maintaining a logbook for the purpose of technology forecasting is often an effective way of doing data collection.

Several authors have presented useful techniques, such as technological progress functions (S-curves), trend extrapolation, the Delphi method, and scenario development. The reader is referred to Wheelwright and Makridakis [44] for further information on this topic specific.

#### **4.17. Evaluate Transferred Technology (29-36)**

The technology evaluation process is one where the stakeholders continuously determine whether the transferred technology is still meeting the set standards to achieve the wanted

outcome. A situation might rise where the transferred technology is not fulfilling needs any more. This might be caused by one of two reasons (29, 30).

Firstly, the technology might become unsuited for solving current development problems. In the case where the technology is no longer suitable for solving unchanged objectives of the LDC, a new technology must be either developed (if possible) or considered for transfer, which will restart the whole technology transfer process again.

Secondly, the objectives can change over time as the needs are connected to the dynamic human factor. This calls for a re-evaluation of the objectives and the needs of the LDC (31). Once new needs, goals, objectives, expectations, aspirations, strengths, and weaknesses are all defined the transferred technology needs evaluation. The stakeholders need to determine whether the transferred technology can be modified to suit the new needs (32). If this is not viable the LDC should develop a new technology or transfer a technology to suit these newly defined needs in which case they restart the technology transfer process.

If however it is possible to adjust/modify the transferred technology to meet new standards an impact analysis (33) should be performed on aspects concerning the end-user. Depending on the outcome of the impact analysis the company should inform end-users on modification and its impact on the existing technologies, services, and products. The users must be informed on all changes in the use of existing technology (34). The technology modification should now be implemented gradually (35). Block 36 suggests the periodic review of the technology to ensure that the involved technology is the appropriate one to achieve the LDC's/company's development goals.

During this "idle period" the LDC has time and should focus on human resource development and research if possible. This is the only way LDCs will ever be able to generate and develop their own technologies and better their independency status.