

MASTER

The improvement of wheelchair provision for people with a disability in Northern Thailand a study on constraints in assistive technology services

Honings, G.J.F.

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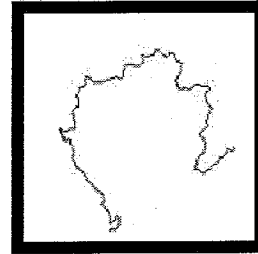
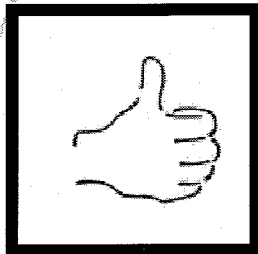
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***The improvement of Wheelchair provision for
people with a disability in Northern Thailand***

A study on constraints in assistive technology services

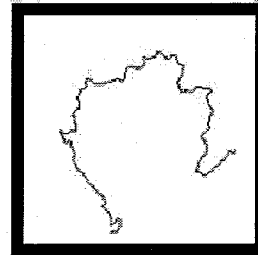
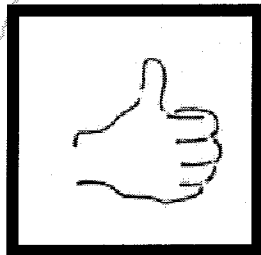
M.Sc thesis

Rudy Honings



***The improvement of wheelchair provision for
people with a disability in Northern Thailand***

A study on constraints in assistive technology services



M.Sc thesis

Rudy Honings

Eindhoven, September 2004

1st Supervisor
Ir. Donné van Engelen

2nd Supervisor
Dr. Marc de Vries

3rd Supervisor
Prof. Dr. A. Szirmai (Eddy)

Eindhoven Technical University (TU/e)
Faculty of Technology Management (TM)
Department of Technology and Policy
Technology and Innovation Policies for Developing Economies

Summary

Persons with a disability (PwDs) in Northern Thailand have a need for appropriate wheelchairs. Besides a shortage of wheelchairs, some wheelchairs are not suitable for the individual PwD, while many others are not manoeuvrable or can not be maintained properly in the rural environment. Social, medical and technical facilitators contribute to the provision of assistive technology devices, like wheelchairs, walkers and crutches. The facilitators which contribute to the provision of appropriate wheelchairs are called Assistive Technology Services (ATS). This research aims to improve the ATS for the provision of wheelchairs for PwDs in Northern Thailand. This research focuses on the constraints in the activities of ATS during the provision of wheelchairs for PwDs, especially on the needs evaluation and technical services.

To be able to understand the different facilitators, literature is studied about medical rehabilitation, western design theories on appropriate assistive technology and experiences of organizations involved in related fieldwork and technology transfer. Literature about assistive technology design shows that in many cases insufficient attention is given to the individual user. Recent design methods like participatory design emphasize the importance of user involvement in product design. Fieldworkers with experience in assistive technology production and technology transfer in daily practice in developing countries consider the PwD as the specialist of rehabilitation and emphasize the need for the attention to the local circumstances. Assessment methods used by rehabilitation specialist provide basic steps, necessary for a professional assessment of a PwD. After a comparison of the methods and models from the literature a new research model is build to enable locating the constraints in the provision of wheelchairs for PwDs. Various phases, structures and activities are combined to achieve a research model representing the necessary steps in the process of wheelchair provision. The literature on rehabilitation and appropriate assistive technology design in developing countries provides the indicators to make the model operational. The indicators represent the necessary activities to come to an appropriate wheelchair provision.

In order to identify the relevant organizations, institutions and PwDs, which are involved in the activities the snowball method is used. In Northern Thailand the ATS consists of three clusters of cooperating actors, which can be held responsible for the provision of wheelchairs for the PwDs. Cluster 1 is a combination of Thai non-governmental organizations (NGOs). Freedom Wheelchair Workshop (FWW) produces assistive technology devices for donation by Chiang Mai Disabled Center (CMDC) and the Foundation to Encourage the Potential of Disabled Persons (FEPDP). Cluster 2 contains rehabilitation centers supported by international non-governmental organizations (INGOs). Northern Child Development Center and Mc Kean rehabilitation Center receive wheelchairs from the Wheelchair Foundation and Wheels of Hope. In Cluster 3 the local pharmacy stores sell wheelchairs. The wheelchairs are produced by Thai manufacturers Siam, Singha and Soma and are sold through the dealers Pharma Choice and Pharma Store. All the clusters and actors are examined by a mix of data collection methods. The viewpoints of all actors are examined by interviewing key persons, observing actor activities, studying their documents and interaction with the PwDs and caregivers.

The results of the empirical research show a variety of constraints. Freedom Wheelchair Workshop in Cluster 1 is the only workshop that makes wheelchairs usable for rural conditions and can make wheelchairs that fit the client, but the capacity of the workshop is limited. The number of home visits and the skills to assess the needs of the PwD are limited. In Cluster 2 the local rehabilitation centers Mc Kean and NCDC have all the knowledge and skills to examine the needs of the individual PwD and caregivers, but they have insufficient time and capacity. For the provision of wheelchairs the rehabilitation centers are restricted by the diversity of models donated from the Wheelchair Foundation and Wheels of Hope. Most models are only usable in urban conditions and personal adaptations, accessories and local maintenance are problematic. The local pharmacy stores in Cluster 3 can sell a diversity of wheelchairs, but most of the models are only usable indoor or in urban conditions. The product range of the pharmacy stores depends on the product range of the manufacturers. Some manufacturers can provide custom made wheelchairs, but the quality of their service depends on the limited skills of the sales person. All the clusters have difficulties in activities where social, medical and technical aspects should be integrated. There is little cooperation between facilitators and PwDs. All clusters have difficulties in realizing ergonomic seating systems and there is no attention for short term training and evaluation of wheelchair use. Wheelchair manufacturers have little contact with the PwD and fail to adapt their products to the rural circumstances. This can result in a limited use of the wheelchairs and early breakdown.

SUMMARY

Through several ways, conclusions and recommendations are drawn. Every analysis of a cluster and actors within the cluster is followed by conclusions and recommendations. The results of a comparison between the clusters and a comparison of the results of similar actors are used to come to overall conclusions for all clusters and facilitator. This results in the following conclusions and recommendations. In most cases where the provision of assistive technology fails insufficient attention is given to PwDs due to limited skills, time and capacity of the facilitators. Therefore it is recommended to organize regular meetings to discuss the problems and opportunities that can lead to an improvement of wheelchair provision for PwDs in Northern Thailand. By involving PwDs and caregivers during the entire procedure of wheelchair provision, many problems can be prevented or solved. PwDs with experience in wheelchair use can help facilitators in the provision process. Manufacturers can try to reduce the need for maintenance by paying more attention to durability of parts and materials. Experienced wheelchair users can also assist in training PwDs in wheelchair use and improving the awareness and ability to maintain a wheelchair. Since 80% of the PwDs live in the rural environment there is a market for wheelchairs designed for use in rural circumstances. Cooperation between Thai manufacturers with experience in alum alloy wheelchair production and organizations that have experience with appropriate wheelchairs, like FWW and Motivation can result in a great improvement of wheelchairs with regard to the maintainability, manoeuvrability and availability of wheelchairs. Suitability of the wheelchairs can be improved by involving experienced wheelchair users to assist during the inventory of needs and matching and selection of wheelchairs. Although the technical skills to make special ergonomic seating systems and special accessories are available, only a few organizations actually make seating systems. The production of special seating systems is an opportunity for new production initiatives and can be beneficial for many PwDs.

Contents

SUMMARY	I
CONTENTS	III
PREFACE.....	V
INTRODUCTION.....	VII
<u>CHAPTER 1 PROBLEM SETTING.....</u>	<u>1</u>
1.0 INTRODUCTION	1
1.1 WHEELCHAIR NEEDS IN THAILAND	1
1.2 CURRENT WHEELCHAIR PROVISION IN THAILAND	1
1.3 ASSISTIVE TECHNOLOGY SERVICE (ATS).....	3
1.4 ACTORS IN ASSISTIVE TECHNOLOGY SERVICE IN THAILAND	3
1.5 RESEARCH AIM AND PROBLEM DEFINITION	7
1.6 DELINEATION.....	9
<u>CHAPTER 2 THEORETICAL FRAMEWORK & RESEARCH INSTRUMENT.....</u>	<u>11</u>
2.0 INTRODUCTION	11
2.1 DESIGN AND PRODUCT DEVELOPMENT THEORY.....	11
2.2 APPROPRIATE ASSISTIVE TECHNOLOGY DESIGN IN DEVELOPING COUNTRIES	13
2.3 MEDICAL REHABILITATION	15
2.4 THE RESEARCH MODEL.....	15
2.5 OPERATIONALIZATION OF THE RESEARCH MODEL.....	19
<u>CHAPTER 3 DATA COLLECTION & ANALYSIS.....</u>	<u>23</u>
3.0 INTRODUCTION	23
3.1 THE IDENTIFICATION OF ACTORS, NETWORK AND ACTIVITIES	23
3.2 EXECUTION OF THE SNOWBALL SAMPLING	23
3.3 THE ACTORS RESPONSIBILITY AND CLUSTERS.....	25
3.4 RESEARCH DATA COLLECTION	31
3.5 RESEARCH DATA ANALYSIS.....	33
<u>CHAPTER 4 RESULTS</u>	<u>37</u>
4.0 INTRODUCTION	37
4.1 RESULTS CLUSTER 1	37
4.2 RESULTS CLUSTER 2	41
4.3 RESULTS CLUSTER 3	43
4.4 RESULTS CLUSTER COMPARISON.....	45
4.5 RESULTS ACTOR COMPARISON	47
<u>CHAPTER 5 CONCLUSIONS.....</u>	<u>49</u>
5.0 INTRODUCTION	49
5.1 CONCLUSION CLUSTER 1.....	49
5.2 CONCLUSION CLUSTER 2.....	51
5.3 CONCLUSION CLUSTER 3.....	53
5.4 CONCLUSION ACTOR AND CLUSTER COMPARISON	55
5.5 OVERALL CONCLUSION ON ATS IN NORTHERN THAILAND	57

CHAPTER 6 RECOMMENDATIONS	59
6.0 INTRODUCTION	59
6.1 RECOMMENDATIONS CLUSTER 1	59
6.2 RECOMMENDATIONS CLUSTER 2	63
6.3 RECOMMENDATIONS CLUSTER 3	65
6.4 OVERALL RECOMMENDATIONS FOR CLUSTERS AND ACTORS	67
6.5 REFLECTION ON ATS	67
6.6 RECOMMENDATIONS FOR FUTURE RESEARCH	69
LITERATURE.....	75
APPENDICES.....	77
I. AN INTRODUCTION TO THAILAND AND THE DISABLED PEOPLE.....	78
II APPROPRIATE ASSISTIVE TECHNOLOGY:- APPROPRIATE WHEELCHAIRS?	82
III APPROPRIATE ASSISTIVE TECHNOLOGY- A DISCUSSION	84
IV APPROPRIATE ASSISTIVE TECHNOLOGY- A CHANGE IN DEVELOPING AID POLICIES.....	85
V. REHABILITATION ASSESSMENT METHODS AND PRACTICE.....	87
VI FURTHER READINGS AND REFERENCES.....	90
VII. CREATION OF THE RESEARCH MODEL	93
VIII OPERATIONALIZATION OVERVIEW	106
IX RESEARCH INSTRUMENT	110
X. INDICATOR DETAILS AND REFERENCES.....	112
XI CONTROL OF REPRESENTATIVENESS	117
XII IDENTIFICATION OF ACTORS AND NETWORK.....	119
XIII INVENTORY OF ATS ACTORS.....	120
XIV INVENTORY OF WHEELCHAIR MANUFACTURERS AND IMPORTERS IN THAILAND.....	121
XV OVERALL DATA COLLECTION OVERVIEW.....	122
XVI DATA COLLECTION SHEETS	124
XVII INDIVIDUAL CASES	145
XVII. I CLUSTER 1	145
XVII.II CLUSTER 2.....	151
XVII.III CLUSTER 3.....	153
THESES IN TECHNOLOGY AND DEVELOPMENT STUDIES.....	154
GLOSSARY	156
GLOSSARY OF MANUAL WHEELCHAIR COMPONENTS	159
LIST OF ABBREVIATIONS.....	160

Preface

A few days after I arrived in Chiang Mai I read an article in the Bangkok Post: "Thailand donates wheelchairs to Afghanistan". The first impressions of amazing Thailand got disturbed by this article, since I had just seen the great need of appropriate wheelchairs. I wondered why a country would donate wheelchairs to another country, while the need in the country itself was so enormous. It seemed such a contradiction. Was it a noble sacrifice under Buddhist influences for a better karma? Maybe a political gesture or was it just a business deal? Although globalisation slowly opens borders, a lot of borders still remain in the heads of people. During the period of seven months in Thailand I worked as a volunteer at several organizations. I travelled from the big city of Bangkok to remote villages in the military zones of Laos, where the Hmong tribes are still trapped in the legacy of the cold war and no "farang" had visited for many years. I crossed many borders created by wealth, discrimination, culture, religion and nature. The article in the Bangkok post said that the wheelchairs from Thailand were cheap and of good quality, so a Japanese organisation had bought them. While Thailand exported wheelchairs for donation in Afghanistan, American donor organizations donate second-hand wheelchairs and buy new wheelchairs in China and donate them in Thailand. Is development aid is just another business slowly changing by the rules of globalisation?

I worked together with disabled people and small organizations and experienced the barriers which they come across in daily life. The provision of wheelchairs turned out to be a complex situation, where a lot of organizations and individuals all try to make the best match between a person with a disability and the well fitting wheelchair. One the end of the day, they all want to see the happiness on the face of a person, who just received some help. Maybe it is irrelevant whether they do it for the disabled, for themselves or for the Gods. As long as their action contributes to some kind of improvement.

This thesis and my work as a volunteer is my contribution to the improvement. Many questions can be answered, although I wonder what my motivation is. One thing is certain. I had a great time with the people around me and used the opportunity to finish my study at the university with great satisfaction. While the Thai cultural habit would certainly prescribe a special thank-you-ceremony for all the people and organizations that helped me in one way or the other, I will prevent loss of face by thanking all the people and organizations who helped me to realise this graduation thesis.

Deurne, The Netherlands - My father and mother, who left the piles of paper on the places where I put them. My friends, who wonder what I'm studying.
Eindhoven, The Netherlands - Dr. Henny Romijn, Prof. Dr. A Szirmai, Dr. Marc de Vries, Ir. Donné van Engelen, for the guidance during my (re)search.
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Bangkok Thailand -Tanawat Rungsongtivakorn, (Siam), Sukhovit (THAIWheel), Kornvipa (Pharma Store Bangkok), Kuhn Akawut (Singha).
Vientiane, Lao PDR - Boonsy Duangkhemthong (AAR Laos) and Kirsten Lentz (Handicap International Lao)
Thailand, various places - All the others who came and travelled along: Wendy, Jakathair and family, David, Carina, and all the others, of whom the faces and their smiles are left in my memory.

Eindhoven, September 2004

Ing. Rudy Honings

Introduction

This report is my Master of Science thesis for the department of Technology and Development Studies, Faculty of Technology Management at the Eindhoven University of Technology. It is the final result of the study program Technology and Innovation Policies for Developing Countries, recently renamed Technological Innovation Science (B.Sc), Technology and Policy (M.Sc), cluster Technology and Development Studies. This thesis is based on research performed in Thailand and Laos between September 2003 and April 2004. The research started on behalf of The Foundation to Encourage the Potential of Disabled People (FEPDP) in Chiang Mai, with approval of the Eindhoven University of Technology. On invitation of FEPDP, I started to volunteer in their Freedom Wheelchair Workshop (FWW) to improve the design of assistive technology devices, like wheelchairs, walkers and crutches. Their primary interest was the actual improvement of their current products. During my activities it became obvious that other constraints had a negative influence on the provision of wheelchairs. This made it necessary to review the first research proposal. The improvement of the wheelchairs itself would not improve the actual match between wheelchair and PwD. Therefore it is decided to do a wider study to obtain more insight in the total of activities needed to achieve a good match between the user and appropriate wheelchairs, by analysing the facilitators of assistive technology services that are able to provide wheelchairs for people with a disability in Northern Thailand. Several organizations are contacted and interested in the research in a wider context. So this research is performed on behalf of several organizations occupied in the assistive technology services in Thailand and Laos. Since the operating area of FEPDP is Northern Thailand, the research focuses on the ATS in that area.

This report is structured in chapters and appendices. In the appendices give detailed information on certain subjects and can be found in the back of the report. After the appendices a glossary and list of abbreviations clarifies specific information on scientific fields of social, medical and technical issues on rehabilitation. Chapter 1 explains the need of wheelchairs in Thailand and how the wheelchairs are provided. The definition of the assistive technology service is introduced and used to describe the situation of actors contributing to the assistive technology service in Northern Thailand. The chapter closes with the research aim, the problem definition and delineation. The aim of the research is reached by the construction of a suitable model to be able to identify the actors and activities where the assistive technology service fails. This model is constructed in the second chapter. Literature study from the medical rehabilitation and design literature and experiences from technicians working in the assistive technology service in developing countries provide the elements for the model. The construction of the model is explained and the model is made operational. Chapter 3 explains how the contributing actors are identified and which methods were used to collect and analyse the data. There are three clusters of cooperating actors that provide wheelchairs in Northern Thailand. These clusters are examined with respect to the individual activities and cooperation. Chapter 4 gives the results of the analyses of the data of the different clusters. Per cluster the data is interpreted to be able to locate where individual actors and cooperating actors succeed and fail during their activities of assistive technology provision. Chapter 5 states conclusions for the individual actors and cooperating clusters. The last chapter gives recommendations to the actors and clusters to be able to improve the assistive technology provision. The research is evaluated to give suggestions for further research.

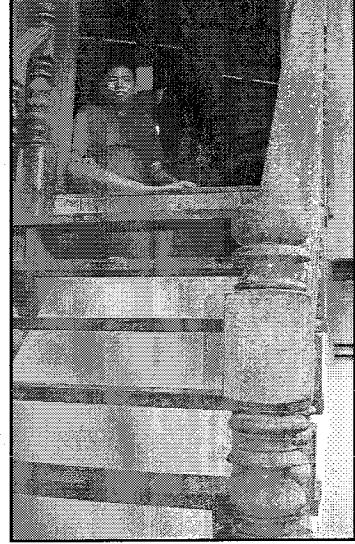
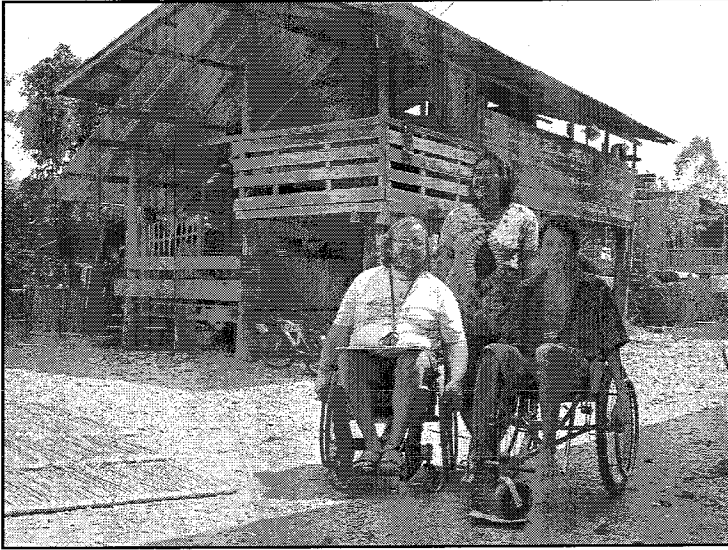


Figure 1 & 2. Without assistive technology, many people with a disability can not get out of their house. The provision of appropriate assistive technology is an important precondition for social participation.



Figure 3. Standard hospital wheelchairs are not appropriate for use in rural areas. The wheelchairs do not give sufficient support and footrests are not adjustable to the individual needs. Due to the small front caster wheels and the position of the pushrim they are difficult to propel. This makes the PwD dependent on caregivers. Bearings and tires deteriorate on sandy roads and maintenance and repair is often problematic.

CHAPTER 1 PROBLEM SETTING

1.0 Introduction

This chapter introduces the problem of wheelchair provision in the context of Thailand. Firstly the need for wheelchairs in Thailand is explained, because persons with a disability (PwD) often depend on a wheelchair for their mobility. Without mobility they can not take part in social life. A lot of PwDs in Thailand do not have a wheelchair, while others have a chair that is inappropriate. Therefore the current wheelchair provision in Thailand is explained. The provision of wheelchairs is done by assistive technology services. Any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device is called assistive technology service (ATS). Since ATS is responsible for the provision of wheelchairs, the definition is further explained and the actors that contribute to ATS in Thailand are introduced. After the explanation of the situation of ATS in Thailand, the research problem and research aim will be defined. In the last paragraph the problem is delineated to avoid misunderstanding regarding the content of the research.

1.1 Wheelchair needs in Thailand

The participation of persons with a disability in society is different from the participation of able persons. Limited participation in society can result in isolation and a limitation of the development due to limited social interaction, exposure to education and employment. For many PwDs assistive technology devices are necessary to make them mobile (figure 1 & 2). The exact need of wheelchairs is unknown, but nearly 2,750,000 people in Thailand have limb or trunk impairment. This includes children with Cerebral Palsy¹ (The National Association of the Deaf in Thailand, 2004). In the Northern provinces nearly 80% of the PwDs are living in a non-municipal area, where the infrastructure is undeveloped (Ministry of Social development and Human security, 1999). The number of provided wheelchairs is not sufficient and many provided wheelchairs are inappropriate.

1.2 Current wheelchair provision in Thailand

A diversity of organizations provides wheelchairs. Besides the provision of wheelchairs by the government, NGOs and INGOs donate assistive technology devices. Several manufacturers and workshops produce wheelchairs. Most wheelchair manufacturers are located near Bangkok and produce wheelchairs mainly as part of a hospital collection. Besides donations of second hand wheelchairs, large numbers of new wheelchairs are donated by INGOs, imported from China. The diversity of wheelchair providers results in a wide variety of products. In recent years, several local initiatives are taken to combine the creation of employment with the production of assistive technology devices for PwDs. Some of the models made are more appropriate for the rural circumstances. The diversity of wheelchair providers results in a mix of traditional hospital wheelchairs, new and second hand donated and low-tech functional wheelchairs built in small workshops or medium scale enterprises.

Inappropriate wheelchairs for the individual PwD

In many cases organizations and institutions fail to match the wheelchairs with the individual user. Sometimes this is because there are no suitable models available. In other cases it is because organizations do not realize that the individual needs of every single PwD are different and change over time. For instance hospital wheelchairs are often very wide to fit the majority of the hospital patients. These wheelchairs do not provide sufficient body support for long-term individual use. This can result in uncomfortable sitting position, back-, neck- and headache, spasm or further deformation of the body. The need of adequate pressure relief is essential to prevent skin problems and nerve

¹ **Cerebral palsy** or **CP** is a group of disorders associated with developmental brain injuries that occur during foetal development, birth, or shortly after birth. It is characterized by a disruption of motor skills, with symptoms such as spasticity, paralysis, or seizures. Cerebral palsy is also known as static encephalopathy. It is no longer considered a disease, but rather it is a chronic non-progressive neurological disorder. The incidence is about 1.5 to 4 per 1000 live births. There is no cure, but therapy may be helpful. It has one of the highest lifetime costs of any birth defect.

damage, but seating systems are often not given the necessary attention. An insufficient fitting wheelchair is often difficult to propel, which makes the PwD more dependent on other people.

Inappropriate wheelchairs for the environment

Since most wheelchairs are originally designed for indoor use, many wheelchair models are only usable in indoor situations or in outdoor situations with well-developed infrastructure. These circumstances can only be found in urban areas. In the rural areas the usability of these wheelchairs is very limited. Often wheelchairs are not adjusted to the road conditions and brake down very fast in rural circumstances. Spare parts are hard to get and repair is costly or impossible for local craftsmen (UN, 1997). In the rural areas the infrastructure is limited. There are many steep and unpaved roads. Despite the high local demand of suitable wheelchairs for rural circumstances only a small number of organizations make wheelchairs suitable for rural conditions.

1.3 Assistive technology service (ATS)

This paragraph defines assistive technology service, since the assistive technology service is responsible for the provision of assistive technology devices. The next paragraph deals with the situation of Thailand. The definition of ATS is taken from the individuals with a disability act, IDEA 1990, PL 101-476. The sub-definitions are given a reference, noted in bold between brackets. The names are not chosen to cover the whole content of the parts of the definition and are only introduced for an easy reference to the parts of the definition.

Assistive technology service is defined as:

Any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device. This term includes the sub definitions—

*(A) the evaluation of the assistive technology needs of an individual with a disability, including a functional evaluation of the impact of the provision of appropriate assistive technology and appropriate services to the individual in the customary environment of the individual; (**Needs evaluation**)*

*(B) services consisting of purchasing, leasing, or otherwise providing for the acquisition of assistive technology devices by individuals with disabilities; (**Financial services**)*

*(C) services consisting of selecting, designing, fitting, customizing, adapting, applying, maintaining, repairing, or replacing assistive technology devices; (**Technical services**)*

*(D) coordination and use of necessary therapies, interventions, or services with assistive technology devices, such as therapies, interventions, or services associated with education and rehabilitation plans and programs; (**Coordination**)*

*(E) training or technical assistance for an individual with disabilities, or, where appropriate, the family members, guardians, advocates, or authorized representatives of such an individual; (**Personal training**) and*

*(F) training or technical assistance for professionals (including individuals providing education and rehabilitation services), employers, or other individuals who provide services to, employ, or are otherwise substantially involved in the major life functions of individuals with disabilities (**Professional training**).*

1.4 Actors in Assistive technology service in Thailand

In Thailand there are many actors that directly assist an individual with a disability in the selection, acquisition or use of an assistive technology device. The responsibility and execution of activities is



Figure 4. Some caregivers try to help as much as they can and make a wheelchair by themselves.

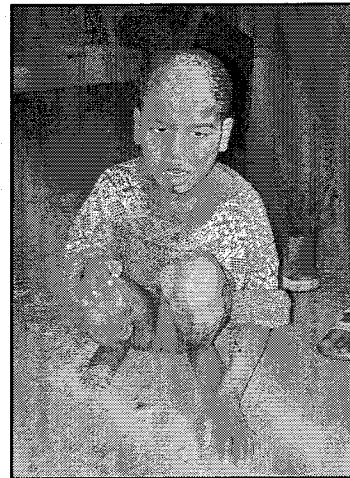


Figure 5 & 6. The provision of assistive technology is only a small step in the rehabilitation. Basic social and medical care has the first priority. Nutrition, basic hygiene and stimulation of body and brain are some basics for child development. The parents of the child on the left tried to take care as well as possible, but poverty makes it difficult to get social and medical assistance. The 13-year old boy on the right was found during a CBR visit. The last 2 years he lived with his 11-year old brother, who never went to school.

divided over a variety of social, medical and technical facilitators of governmental and non-governmental organizations (NGOs). There are also a lot of organizations indirectly involved in ATS in activities like policy formulation, implementation and issues concerning human rights and equal opportunities for PwDs. This research only looks at the organizations which directly assist.² In this paragraph the most important social, medical and technical facilitators are mentioned, with their contribution to the different aspects of rehabilitation. Here again the line of the definition of ATS is followed.

(A) Needs evaluation

The initiative of the needs evaluations depends on the actual rehabilitation strategy. Sometimes people come to the hospital and receive care from the rehabilitation units. In other cases, PwDs are assisted in their own environment by social workers involved in community based rehabilitation (CBR). In Thailand, social facilitators, medical facilitators and technical facilitators take part in the needs evaluation because there is a shortage of rehabilitation specialists.

(B) Financial services

The way in which wheelchairs are provided differs from location to location. In urban areas consumers can buy a wheelchair on their own initiative at a pharmacy store or request for a wheelchair at several rehabilitation units in hospitals. Since most PwDs can not buy their own wheelchair they go to hospitals that have a rehabilitation unit. Other wheelchairs are provided by INGOs and NGOs. In many cases, people have to contribute to the costs of the assistive technology service, but the majority is financed by governmental support and donor organizations. In rural areas it is much more difficult to obtain assistive technology devices. PwDs depend more on their own initiatives. Assistance comes from social facilitators of CBR or outreach visits, often working for INGOs and NGOs. Sometimes PwDs and caregivers make their own devices.

(C) Technical services

Technical facilitators provide the majority of the technical services. A variety of large wheelchair manufacturers and medium or small-scale workshops produce wheelchairs. The large manufacturers sell their products in the urban areas through a dealer network. Some hospitals depend on the wheelchair dealers for service. Other hospitals and rehabilitation units have their own workshop for fitting, customizing, adapting and repair. In many villages there is no technical facility for wheelchairs. PwDs depend on visits from CBR-workers or local metal workshops and bicycle shops.

(D) Coordination

For an adequate rehabilitation a variety of therapy and training can be needed to try to achieve an optimal body function necessary for daily activities and participation of PwD in society. In some cases this is a struggle of a lifetime, while in other situations an impairment is stable and after a short period of rehabilitation PwDs can function quite well in society. The coordination of services depends on the rehabilitation strategy and the responsibility of the service providers (see Appendix I: An introduction to Thailand and the disabled). The need of the therapies and training depends on the actual impairment of the PwD. Often the personal factors of the PwD determine if he can visit a certain institution and receive certain aspects of service. There are centers, specialized in certain disabilities, while others have an age limit (Prayat Punong-ong, 1997).

(E) Personal training

Wheelchair users and caregivers have to learn how to use wheelchairs safely. Intensive training improves the confidence, manoeuvrability and control over the wheelchair. After training PwDs and caregivers are much better in judging situations and wheelchair control. This gives more confidence to go out. Issues like small repair and maintenance are important to keep a wheelchair in condition. Most medical and technical facilitators are reluctant to give training. If training is given this is done at the specialized rehabilitation centers and by self-help organizations. Other wheelchair users get more control and confidence by attending sports lessons at special education centers.

(F) Professional training

The amount of knowledge of professionals depends on the actual function of the person, but all professional people that come into contact with PwDs should have basic knowledge about wheelchairs. The way of training of professionals differs from organization to organization. INGOs and

² For a better understanding of the different organizations, their responsibility and involvement, more information can be found in Appendix I and VI).

NGOs often train their own staff the necessary skills or depend on skilled volunteers. The University hospitals train Medical facilitators, but special attention to rehabilitation issues is limited (Prayat Punong-ong, 1997).

1.5 Research aim and problem definition

The previous paragraphs introduced the situation of PwDs in Thailand and the assistive technology service. The need for wheelchairs is much higher than the provision of wheelchairs. Besides the shortage of wheelchairs many wheelchairs are not appropriate for the PwD in the rural environment. The assistive technology service fails to match the device with the PwD or can not provide the appropriate wheelchairs. Because the provision of appropriate wheelchairs for PwDs is essential for their mobility and community participation there is a need for improvement. This research can help to create a better understanding of activities that lead to appropriate wheelchair provision. A better understanding makes it possible to improve the activities of the assistive technology service and cooperation between the involved organizations. An improvement of the activities can lead to an overall improvement of assistive technology services and the creation and provision of more appropriate wheelchairs for PwDs. An improvement of wheelchair provision will make PwDs more mobile and in some cases more independent in daily life. This will lead to better opportunities for attending regular education, employment or income generation and social circumstances. Considering the arguments presented above it has been decided to state the research aim of this study as follows:

The aim of this research is to improve the assistive technology service for the provision of appropriate wheelchairs for people with a disability in Northern Thailand.

The assistive technology services can be improved by removing the constraints in the activities of assistive technology services. Before the constraints can be removed, they must be identified. Therefore the related problem definition is as follows:

Which constraints can be found in the activities of assistive technology service during the provision of appropriate wheelchairs for people with a disability in Northern Thailand?

The problem definition can be researched on many aspects related to the sub-definition of ATS. The definition of ATS already showed that there are many actors involved in a diversity of activities. It is not possible to do research on all of the aspects, but since the aspects are also core-related, it is not possible to completely isolate the sub-definitions of ATS. The most important sub-definitions, related to the problem in the assistive technology service are the needs evaluation (A) and Technical services (C). These sub-definitions contain the core problem between the properties of the failing wheelchairs and the need of appropriate wheelchairs. The sub-definition (A) of evaluation can be considered as the activity of defining the actual problem and imagining the future situation. This is the phase where the problem of the PwD is identified and personal and environmental needs should be recognized. The sub-definition (C) technical service is very important, because it is the phase where ideas are materialized and solutions are realized in an assistive technology device. The combination of these activities should lead to the provision of appropriate wheelchairs. This is only possible if the facilitators, which provide these parts of the ATS, would improve their individual activities and the cooperation with other facilitators. Due to tension between the facilitators, they sometimes fail to cooperate with each other and are not able to provide appropriate wheelchairs for PwDs. In this context, appropriate means suitable for the personal needs of the individual PwD, manoeuvrable in the local environment and maintainable and repairable by the local labour force (see Appendix II, III and IV). By designing a model where these activities are combined, the needs evaluation and technological activities can be integrated. With this model, the gap between the different actors involved in the assistive technology provision can be investigated and narrowed down. This model should be usable to analyse the empirical situations of individual and cooperating actors.

1.6 Delineation

Due to the relations between the sub definitions of ATS it is not possible to fully isolate the needs evaluation (A) and technical services (C) from the other sub-definitions. The sub-definitions of ATS, financial services (B) and coordination (D) are more organizational and financial aspects, needed to provide the total spectrum of assistive technology services in the context of society. These aspects are important to be able to give the appropriate support to the PwD on the proper time. The same goes for personal and professional training (E and F). Personal training (E) is an important precondition to achieve proper use of wheelchairs and an optimal mobility and social participation. For all the service providers there is a need for qualified people to do the job. Therefore there is a need for professional training (F). Without an idea about these aspects, the problem would be simplified. Qualified staff is not always available in Thailand. The training of staff is a problem of later concern. The same goes for coordination and finances. The medical, social or technical facilitators often arrange coordination and finances. These aspects can be considered as part of the problem, because these aspects determine if the PwDs can purchase assistive technology devices. These aspects ought to be taken into consideration during the needs evaluation (A) and the technical services (C) as well. The subject of training can be of later concern. This study wants to identify where the process of matching the needs of the PwD and the provision of an appropriate wheelchair fails, because that seems to be the major problem during the provision of assistive technology devices. Other aspects can be the subject of research of later studies. This study might lead to recommendations on where more training is needed, but it is too early to take these aspects into consideration during this research. The most important aspects will be examined in the theoretical part. Other aspects found will be mentioned, but only further examined, if their importance becomes evident in the literature study. The next chapter will examine the most important literature related to the sub-definition (A) needs evaluation and (C) the technical services.

CHAPTER 2 THEORETICAL FRAMEWORK & RESEARCH INSTRUMENT

2.0 Introduction

The literature should give us an idea how assistive technology services work in theory and which methods and models are used in daily practice. The literature should provide us with structures and activities which represent the way of acting. Since social, medical and technical sciences have all developed their own theories and accompanying methods, a diversity of literature was used to find standards, methods, theories and tools related to assistive technology service for the provision of wheelchairs. For a better understanding of the activities during the needs evaluation, the literature about rehabilitation assessment is examined. This literature shows the rehabilitation assessment in practice. For a better understanding of the technical services, literature on assistive technology design is studied. Since most literature is about theory and practice as seen from a western context, the literature study also includes experiences from fieldworkers on appropriate assistive technology production in developing countries.

The literature is used as a source to build a model that can be used to do research on assistive technology services in Northern Thailand. The model and research instrument makes it possible to do empirical research and find an answer to the research problem. With the model we want to be able to show the constraints and identify the aspects that cause the failure of the process of wheelchair provision in ATS to be able to give recommendations for improvement. The research model is built by comparing and combining the different methods and models from the different literature (see Appendix V and VI). This is done to be able to find the appropriate structure and activities for the research model. Finally, the construction of the model is explained and the research model is made operational. A more detailed explanation of the creation of the research model and the activities in the model can be found in Appendix VII.

2.1 Design and product development theory

In general product design methods teach us how to design products. Product design is a part of product development. Product development contains not only the product design process, but also the planning of the production process, the distribution and market approach. During product development the decisions are made on what a product is going to look like. Here we concentrate on the design and production development that can help us to build a model to come to appropriate assistive technology. This study concentrates on the demands of the user in his environment, since these aspects have not been given sufficient attention (Poulson, 1996; UN, 1997, Ch. V; Torres, 2001). Before we can concentrate on the user needs, we have to have a structure to relate the activities to.

Most design methods work in several phases of design. The division of design into phases is done to structure the design activity. The development of the phases of design started in the 1960s and evolved into four phases: problem analysis, conceptual design, embodiment design and detail design (Rozenburg & Eekels, 1998, pg. 112). These phases start with the design problem and should consider the user needs and end with a product that should meet the user needs. During the execution of the different phases other specifications will arise that may be in conflict with the user needs. A good designer or design team uses all the relevant input and tries to find a balance between the many contradicting demands during the design process. In many cases engineers and scientists do not look at the market and user needs, because this is given insufficient attention during their education. They are trained to focus on technical problems and assume that the current products satisfy the user needs (Torres, 2001). Designers often base their understanding of users on their own experience. In case of assistive technology design a number of factors can lead to poorly designed assistive technology devices:

- Poor communication between designers and end users
- Inappropriate techniques for information requiring
- Products are often derived from a medical perspective, with a limited scope
- Patients are often perceived as isolated sets of symptoms rather than whole persons
- The styling as medical products can stigmatise the user



Figure 7. 3-wheel steel wheelchair designed by Motivation and produced by Freedom Wheelchair Workshop. The model is very stable and easy manoeuvrable on uneven surfaces.

These factors lead to abandoning or rejecting the use of assistive technology devices (ATD), despite of the clinical benefit. Although the use of the product would be beneficial, the PwD will not use the product. Since most wheelchair designs are originally designed for use in hospitals, many designers look upon a wheelchair as a medical device. Wheelchair design for use in hospitals can be made for a large population, because the intensity of usage is very short. This leads to oversized designs, to fit all users. Designs for PwDs should meet the individual needs. If there is no, or not sufficient communication or interaction between the user and the designer, the actual user needs are not analysed properly (Poulson, 1996).

Several methods and tools have been developed that involve the user in the actual design process. The intensity of the involvement is different. In the Quality Function Deployment (QFD) the first step is to talk to the ultimate users or clients and get them to express their preferences and expectations in their own words. In Total Design the first step is to identify the user needs, followed by the Product Design Statement (PDS). This document contains the views of the customer and will be used in the design process to control, if designs are satisfying (Torres, 2001). During the design process changes can occur because of changed circumstances or changed objectives. Iteration makes the design process a dynamic process, with much possible iteration. In Participatory design or Participative design a large community of people is seen as designers or are a part of the design team (Smith, 1997). Methods like Universal Design focus on the usability of products by all the people of society in the context of the environment to avoid exclusion of persons with a disability and elderly. The different design methods can be used for the design structure and as a source of useful tools. Activities like user analysis, activity analysis and product analysis give the necessary information. The environmental context and the product environment are considered as a part of the problem and receive explicit attention. These activities are the problem definition of the design problem. The problem should be translated into functional specifications. Then prototypes can be built and tested. During the test the usability can be evaluated (Poulson, 1996).

The different design methods presented above can be used for the design structure and as a source of useful tools, but iteration occurs through the process. To prevent a repetition of earlier mistakes, factors of failure in earlier designs are identified. A good design process starts with the user in his environment. During the design of a wheelchair, the user should be involved in the design process. Several methods and tools are found that can contribute to the improvement of user contribution. Because these methods give explicit attention to the user needs, they can be used to improve wheelchair design for PwDs and thus form an important building block for the theoretical model.

2.2 Appropriate assistive technology design in developing countries

Since many design theories are developed to be used in a western context the validity of use of these theories in a developing country can be questioned. Differences technological status, scale of production and influences of the environmental context should be taken into account. Several organizations have been stimulating the design and production of assistive technology in developing countries. They have been participating in the assistive technology services themselves. This resulted in creation of employment and independency, by promoting PwDs in making their own products (see Figure 7) (Motivation, 2000; Hof, 1993). In many developing countries products are not designed, but often copied from existing devices. If there are no products known that can solve a certain problem, PwDs or caregivers will try to find a solution by trial and error. The traditional way of working in developing countries is very pragmatic. The products evolve during the daily work. Prototypes are built and evaluated during the use. Foreign assistance like technology transfer gives the workshops a main concept of existing models. The models are copied and adapted to the individual user and local circumstances. Products are adapted and improved if the users complain. By training the PwD in producing assistive technology devices, he becomes his own expert. Since the PwD already has an idea about what he wants to do with the device, the need for rehabilitation assessment becomes less necessary (Pfaelzer, 1998; Hoff, 1993). Because of the high need for assistive technology, the products are donated and tested by the PwD. During the years several wheelchair designs have evolved in outstanding products appropriate for use in the rural environment. The information about the designs and the production is shared among wheelchair builders worldwide so they can learn from

each other on how to solve environmental related problems. Their experiences and hands-on approach has resulted in a number of designs and design guidelines on wheelchair design, in which the PwD always participates (Madras, 1995; Werner, 1988; Motivation, 2000). These will be used in the operationalization of the model and the research instrument.

2.3 Medical rehabilitation

In most industrialized countries with a well-developed social system special institutions provide wheelchairs for PwDs. In the UK a team of specialist containing a rehabilitation engineer, a physiotherapist and a social worker are involved in the assessment (Mayall, 1995). In America a social worker or medical specialist has the task to assess a user for a proper wheelchair (Ham, 1997). The choice of wheelchair models is limited, because of budget restrictions, or a limited selection of approved models. In other states a small team of specialist is involved in the assessment of seating and wheeled mobility (Bergen, 1998). Assessment always consists of the medical assessment and the determination of the level of independence, the personal situation and wishes of the PwD and primary caregiver. Bergen gives much more attention to seating issues. Mayall makes a selection of assistive technology devices and accessories, a selection of wheelchairs, adaptive equipment and seating systems out of the existing collection, while Bergen first carefully lists the needed properties. The method of Bergen is preferred because the problem is more carefully analysed. The seating systems are judged on advantages and disadvantages of the products, availability, costs, maintenance and the likes and dislikes of the PwD and caregivers. A wheelchair will be chosen, tested and evaluated. If the device does not meet the needs of the PwD, the assessment will be refined. The device will be adapted, or another device will be provided (see Appendix V Rehabilitation assessment methods and practice).

The methods used by rehabilitation teams can be considered as the necessary activities or fields of attention to establish a provision of wheelchairs for PwDs. There are differences in the order of activities, but they contain the same basic structure and have similar activities. It is important to emphasize that it takes professional skills to apply these methods and that the use of the provision of a wheelchair itself does not help the PwD. Besides the provision there is a need for technical and practical training for PwD and caregivers. The assessment methods can be used in a general model of wheelchair provision. All models studied show a structure to identify the user needs, bring up ideas to meet the needs, evaluate the solution and adapt or adjust this. If the problem is not solved or new problems occur, there is a need for further examination. They all emphasize the personal attention to the special needs of the PwD and his lifestyle and have an iterative character. Most PwDs need to be evaluated regularly, since properties of the human body and the needs of PwDs are constantly changing. The aspects mentioned above will be used as building blocks for the research model as well.

2.4 The research model

Introduction

The literature studied in the previous paragraphs contains useful information to come to an appropriate wheelchair provision. Since the literature study is started to be able to make a model for research, the structure and activities in the models are compared. Since most literature shows that there is given insufficient attention to the individual user and his environment, this is given extra attention. This paragraph summarizes how the model is created. In Appendix VII the creation of the model is described in more detail. In the next paragraph the model is operationalized.

The models of assistive technology provision and several design methods all contain valuable elements. After a comparison of the structure and elements of the models a new model is created. First the models are compared. This is done to find similarities and differences in the processes, to be able to make a new model which contains the most relevant aspects. This results in a model with five phases: the problem phase, the ideation, the product phase the evaluation and the phase of operation. The phases can not be strictly divided, because there is an overlap between activities. The structure results in a flow through the phases with feedback, due to the iterative character of the design process

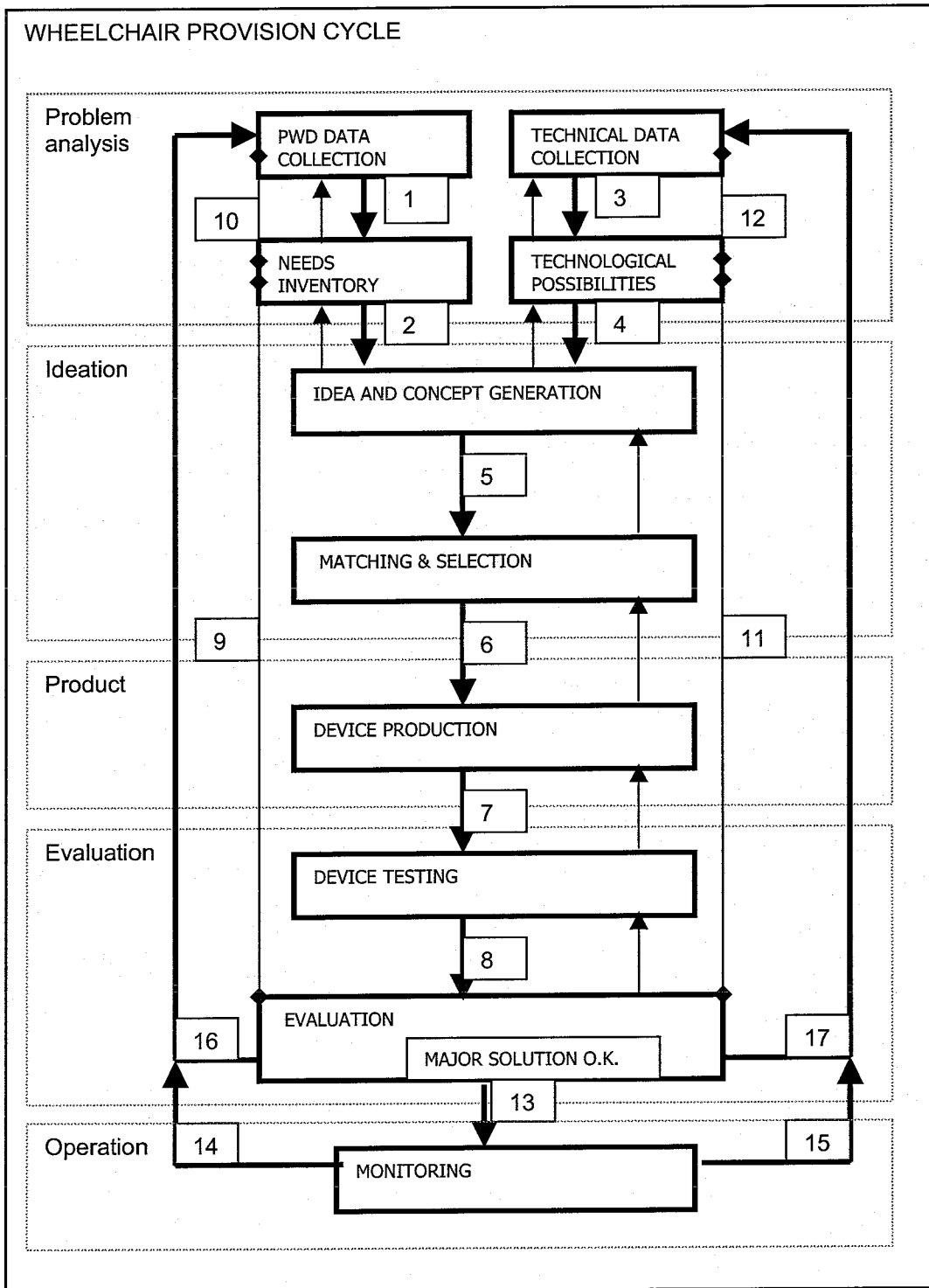


Figure 8. Research Model of assistive technology device provision by ATS in Thailand.

and evaluation. Iteration is also needed, because the body measurements, structures and functions of every PwD change in the long term and the condition of technological devices deteriorate as well. The extra attention needed for the individual user and his environment is embedded in the problem phase. Design literature, and rehabilitation literature both provide methods and tools. Because the rehabilitation literature is more concentrated on the assessment for wheelchairs, this literature is used for a closer examination. Most important issues that can be found in the different literature is the interaction with the actual PwD and his caregivers during the assessment. Without the interaction with the PwD it is not possible to select or produce a good product. The personal factors and environmental factors deserve specific attention, because they define the conditions in which the wheelchair is used. This resulted in the activities of collecting data about the PwD and the inventory of the PwD needs, to be able to define the problem from the vision of the PwD. On the other side, data about the technical solutions for the PwD and the technological possibilities in the given situation can define the problem from the technological side.

Explanation of the research model

By studying the literature it is possible to make a model on how assistive technology services works in theory. Structures and activities are selected which represent the way of thinking and acting. The model can be used to do research on assistive technology services in Northern Thailand. With the model it is possible to do empirical research and find an answer to the research question. With the model makes it possible to show the aspects that can locate the causes of failure of the process of wheelchair provision in ATS, to be able to give recommendations for improvement. Here the main stages within the model of the assistive technology provision are described. Every phase contains different activities. These activities are related to each other, and therefore placed in the same phase. Here is explained how the phases and activities are related and what the activities mean. A more elaborate explanation can be found in Appendix VII. The research model is shown in figure 8. on page 16.

Phase 1 Problem analysis

The problem analysis is the stage in which the problem is analysed and formulated. Here the problem analysis consists of two paths: the first path is the social problem of the PwD in the given situation; the second path is the technical problem of how technology can solve the social problem. The PwD data collection and the needs inventory give a better understanding of the social and medical side of the problem, while the technological data and the technological possibilities reflect the technological side of the problem.

The PwD data collection and the needs inventory are the stages in which the actual social problem is analysed and formulated. In medical terms, in this stage it is clarified in which way the impairment of a person results in a disability and how this leads to a handicap. The PwD data gives the information about the social and environmental circumstances in which the PwD is living. The PwD data collection can be translated into actual needs (arrow 1). The needs inventory is the total of relevant needs and wishes of the PwD and caregivers to make him more mobile in his environment. The needs should be used as input for the ideation (arrow 2).

The chance is high that similar products have been produced earlier, in order to fulfil similar needs. The production technology and the product technology is a main source of technical information for assistive technology devices. Technological data enhances all the information available concerning the production of assistive technology devices. The technological data is a source for the technological possibilities. In the given circumstances not all technological capabilities can be executed, due to environmental constraints and limitations in product and production technology. In developing countries the technological status is not very high. The technological data should be adapted to the actual realistic technological possibilities (arrow 3). The technological possibilities are the collection of all possible partial solutions that can be realized in the given situation. They are the technological input for the ideation (arrow 4).

Phase 2 Ideation

The ideation consists of the Idea generation, selection and matching. During the ideation the needs of the PwD are integrated with the possibilities of assistive technology. New ideas may be generated, or existing solutions may be combined. Partial solutions are found for the different needs and combined

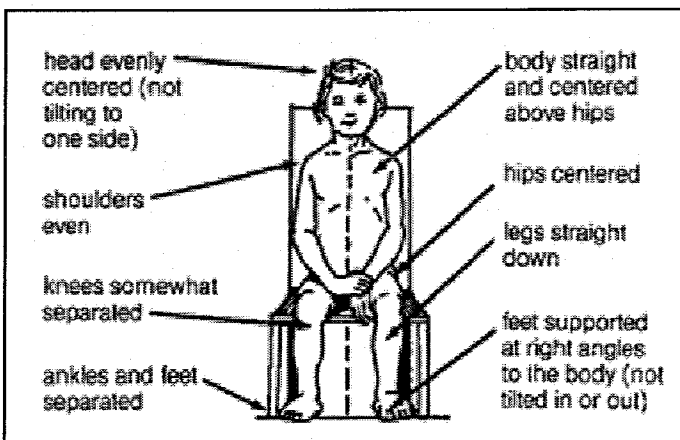
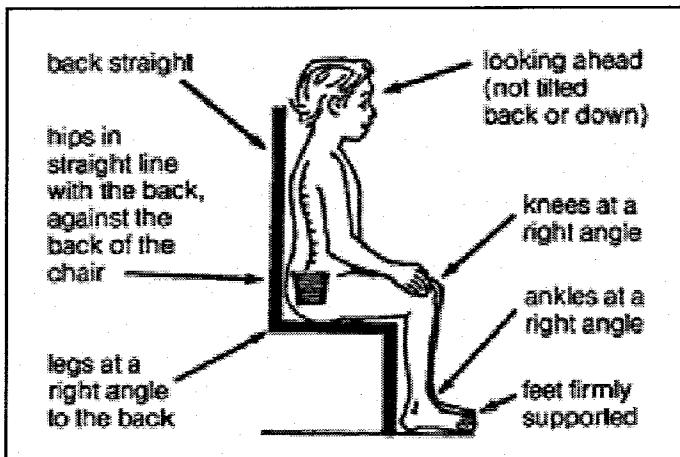


Figure 9. Guidelines can help PwDs, caregivers and facilitators to find an optimal ergonomic position.

into concepts. The ideas and concepts are the input for the activities of matching and selection (arrow 5). During the selection and matching, the possible solutions are valued and selected. The different ideas and concepts are selected with the needs inventory and technological possibilities as a reference for criteria. In this stage the decisions are made on how to solve the problem. The final idea will be used to make or select a prototype or product (arrow 6).

Phase 3 Production

During the production, the ideas are turned into actual devices. The devices can be a prototype, a custom fit model or product out of an existing stock. It can also be a combination of e.g. existing models and new designed seating or accessories. This includes activities like customizing and adapting. If the device is finished it can be tested (arrow 7).

Phase 4 Evaluation

The evaluation consists of device testing and evaluation. In this phase the actual usability of the device is judged. Device testing is the stage where the device is used in order to determine how well it works. Besides the technical prototype testing on strength and safety the device should be tested on the actual usability of the product. The PwD can use the device in the actual environmental setting. The results of the testing should be evaluated (arrow 8). Device evaluation is the assessment to control if the device can meet the specifications of the PwD needs (arrow 9) and technological possibilities (arrow 11). If the needs are not met or if technical problems occur the cause of the problem can sometimes be found in the PwD data collection or Technical data. If the PwD needs are not met, than the PwD data collection can be re-examined (arrow 10). If technical problems occur an evaluation of the technical data can clear the problems (arrow 12). New ideas should be generated or the PwD needs and technological possibilities should be re-examined. It can also occur that the specifications of the PwD needs are met, but that this does not resolve the actual problem. In that case the tests and evaluations can also result in new demands and wishes that were not in scope before. In that case the problem analysis should be reconsidered and phases should be repeated (arrow 16 and 17). If the tests and evaluation give a satisfying result, than the major solution of the problem is found. The major solution can be defined as the stage of successful action of solving the problem on the short term. This means that the product can be given to the PwD for long-term use (arrow 13).

Phase 5 Operational phase (Operation)

The operational phase is the time in which the device is used by the PwD and caregivers. It is the daily use of the product in their environment. Due to the constant changes of the body structures, measurements and personal condition of the PwD and caregivers a social/medical follow up is needed. Of course also the condition of the assistive technology device can change over time. Therefore there is always a need for monitoring. Monitoring is the regularly contact, interaction or observation of the PwD and his device, to be able to asses if the device is still functioning according the specifications and the demanded major solution. This includes the overall assessment of the PwD, overall assessment of state and functioning of the assistive technology device and control on necessary maintenance and repairs. If a device is not functioning according to the specifications, or if the user needs have changed in such a way that normal maintenance and adjustment does not result in a solution, than follow up is needed. This means that the assistive technology device should be changed or replaced. In that case, there should be a repetition of the previous phases (arrow 14 and 15).

The thin unnumbered arrows represent the iteration between the different activities and phases.

2.5 Operationalization of the research model

During the literature search different methods and tools are found to execute the different phases and activities to come to appropriate wheelchair provision. During the operationalization the activities are translated into measurable terms. For the different activities, indicators are found that can be used to analyse the different types of data. By defining indicators, the different methods used can be compared. If possible, the indicators are taken from the literature or derived from methods and guidelines for assistive technology services. This paragraph discusses how the indicators are chosen to be able to measure if certain activities are executed. The research instrument is made by using the

indicators in a list of questions. The questions are used to collect the research data. The list of indicators and the research instrument can be found in Appendix VIII, IX and X.

The PwD-related indicators of the problem phase are found in The International Classification of Functioning, disability and health (ICF) (WHO, 2001). The needs inventory is taken from various assessment methods and literature (Mayall, 1995; Bergen, 1998). Indicators for technical data and technological possibilities are classified with the definition of product and production technology (Van Egmond, 1998). Here the minimum needed information, tools and equipment to produce a wheelchair is used.

For activities in the ideation phase it is difficult to give an indicator because these activities occur often in the minds of people. In those situations, only the result of the activities can be observed. Drawings, sketches or product proposals indicate that the activities take place, but in many small workshops, ideas are immediately put into practice. To be able to interpret the quality of the activities, the drawings, sketches and product proposals, or the result can be judged. The result of these activities is a combination of the previous activities. Since the needs of the PwD vary from client to client, it is only possible to check if the actors pay attention to the general aspects of attention that should be taken into consideration during those processes. For these activities we found subjects of attention and ask during interviews if actors give attention to those aspects. The weaknesses in these activities become visible at the activities of device testing, evaluation and monitoring.

The indicator for the production is the result of the production. This can be a prototype, or an actual product.

During the evaluation and monitoring, the collected data and needs can be compared to the previous collected information. Therefore the same indicators can be used as in the problem phase.

The research instrument is built by formulating questions that contain an indicator. By making closed questions, which can only be answered with yes or no, the execution of activities or parts of activities can be researched (see Appendix VII, IX, and X). The questions together form the research instrument and can be used for different types of data collection like personal interviews or observation of the activities. The indicators can be used to check if certain activities do, or do not occur. If the activities take place, it is registered. The quality of the execution of these activities is measured by taking a higher number of indicators for a single activity. Where possible, direct indicators for the activity are used in the phase of the activity. If that is not possible, the results of the activity or the necessary tools to execute the activity are used. The tools or the result of these tools are the indirect indicators for the activities. For instance reports or files are indicators for the assessment of a PwD. A production facility is an indicator for the possibility to produce.

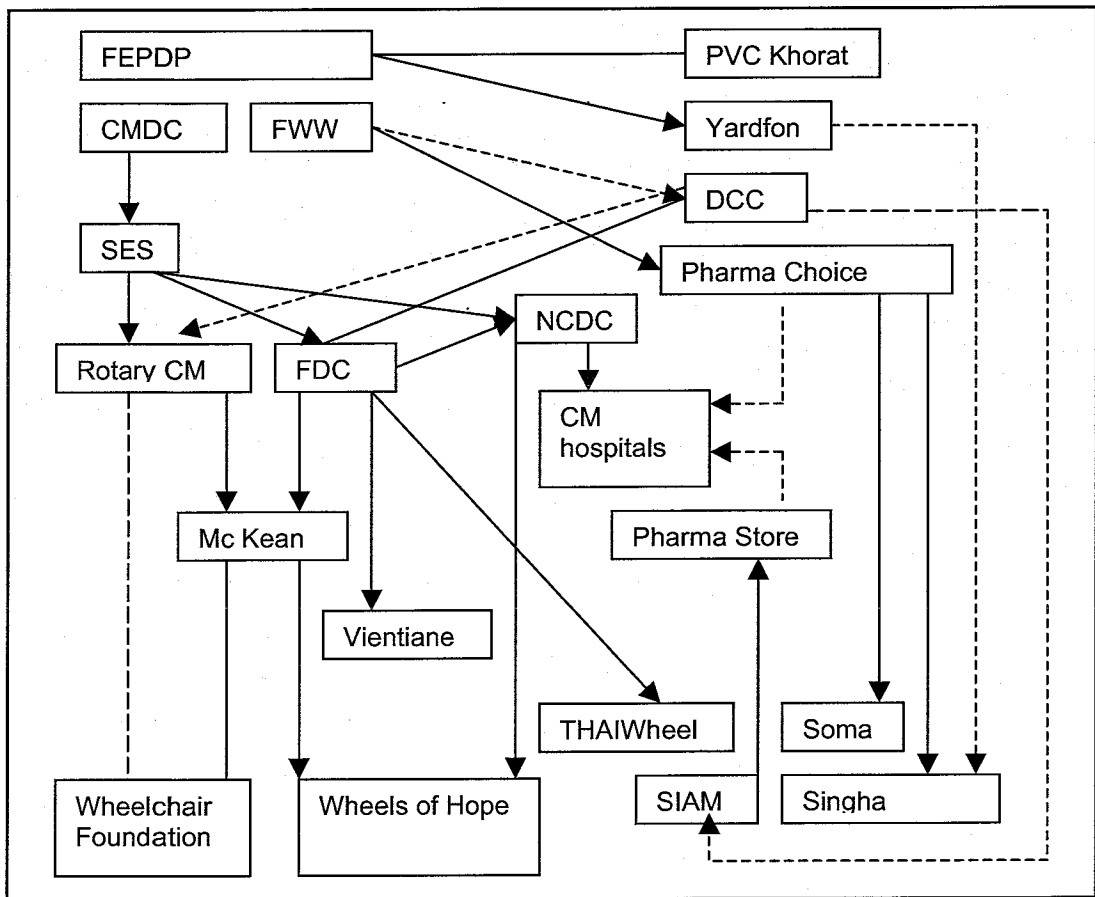


Figure 10. Network of actors as identified by snowball sampling.

CHAPTER 3 DATA COLLECTION & ANALYSIS

3.0 Introduction

This chapter explains how the data is collected in Thailand and how the data is analysed. First it is explained how the snowball sampling method is used to identify the actors and their cooperation in a network. Within the network of actors, three clusters are identified that could provide assistive technology service for the provision of wheelchairs. These clusters are the subject of research. Per cluster it is explained in which way the research data is collected. Finally the research analysis is introduced to be able to understand how the actors within the clusters are examined in more detail on their role and responsibility of the actors within ATS. This is necessary to be able to draw conclusions and give recommendations.

3.1 The identification of actors, network and activities

All the actors that contribute to the assistive technology service can be considered as the object of research. In an ideal situation all the contributing actors of the assistive technology provision should be identified, to be able to value their role in ATS. Out of the total number of actors, a number of actors can be chosen to contribute to the actual research. The units of research are a variety of PwDs, caregivers, social facilitators, medical facilitators and many others. To identify the actors and the network between the actors, the snowball method³ is used. This method is normally used as a method of sampling, but can be used to identify the actors and the network of contributors to ATS as well. Paragraph 3.2 explains how the snowball method is carried out in practice.

The snowball method is applied, because in the beginning it is not clear which actors are involved in the assistive technology service. By starting with interviewing the customers of the Wheelchair Workshop in Chiang Mai a mix of different kinds of actors were identified. The visitors named organizations and the organizations named other organizations. Here it is assumed that the actors that actually come into contact with the PwDs in Chiang Mai are the most important providers of service. This is checked later to verify the representativeness (see Appendix XI). The number of actors investigated and the way of investigation was limited by the given time for the research, the possibility to make contact and the possibility to participate in their activities of data collecting.

Since the research is about the assistive technology service in Northern Thailand, this is the focus area of the research. The assistive technology services are not bounded to a location or a certain area, since wheelchairs can be imported from other areas. The criterion to determine the research area is: all actors that contribute to the provision of wheelchairs for the PwD that lived in Northern Thailand. By using this criterion the actors that are located outside of Northern Thailand but that do contribute to the assistive technology service in Northern Thailand are part of the research as well.

3.2 Execution of the snowball sampling

The research is started on behalf of the Foundation to Encourage the Potential of Disabled People and their operating organizations, Chiang Mai Disabled Centre and Freedom Wheelchair Workshop. These organizations are located in Chiang Mai. Since this is the largest city in Northern Thailand, this location has been chosen to start the snowball sampling. By talking to wheelchair users and their contacts with different interest organizations that have something to do with disabled people, the origin of their assistive technology has been recovered. The people are asked if they knew more wheelchair users or organizations that provide assistive technology services. The persons they mentioned are

³ **Snowball sampling** is a form of sampling proposed by Goodman (1961) whereby a random sample of n individuals is drawn from a finite population. Each individual is asked to name k further individuals; and so on for s -stages. The initial sample solution and its size govern the kind of analysis and inferences that can be drawn from the data. (Parker, 2004) Here the population can be defined as all actors that contribute to the assistive technology service for the provision of wheelchairs for PwD in Northern Thailand.

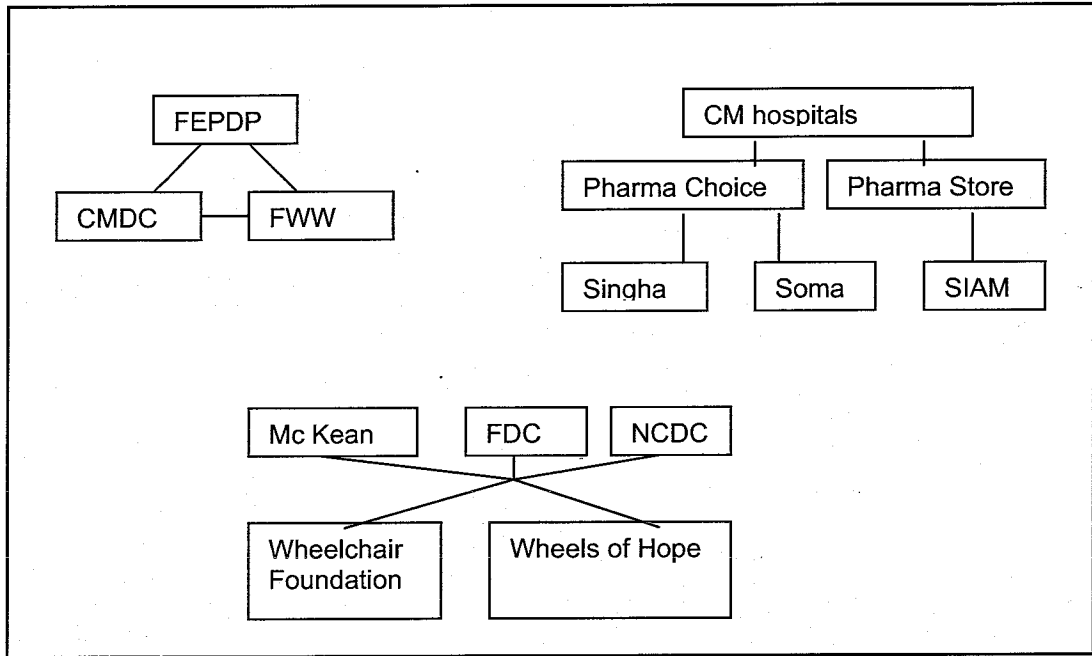


Figure 11. Clusters of cooperating actors in organizational networks.



Figure 12. Founder of Freedom Wheelchair Workshop Geoff Thorsby with employees Kuhn Pho, Chan and Eckachai.

the next subjects of research. Different contacts have been made with diverse institutions that had something to do with the design, production and allocation of assistive technology or some kind of interest within the disabled community. This has resulted in a wide variety of individuals, NGOs, medical facilitators, workshops and manufacturers. Figure 10 on page 22 shows the identification of the actors and networks. A more detailed description can be found in Appendix XII.

3.3 The actors responsibility and clusters

In many situations different actors are responsible for the execution of certain phases or activities. It is important to identify this responsibility because in cases where responsibility is divided, it is possible that cooperation is needed to cover the activities of an appropriate assistive technology provision. This responsibility can be given by legislative, political, or religious and cultural institutions. NGOs and foundations can give themselves a responsibility, based on ideals of the organization. The actor or cluster can be expected to execute those activities that belong to their responsibility. In many situations, different actors are responsible for the execution of certain phases or activities. This paragraph describes the three major clusters for assistive technology service identified in Northern Thailand. The way of cooperation is explained and the responsibility of the organizations is mentioned. A cluster is defined as a network of cooperating actors, which cover the responsibility of the activities of the assistive technology service for the provision of wheelchairs. The term cluster is used because some of the actors in the cluster also form a network with other actors. These networks are not examined here. Figure 11 shows the identified clusters that provide wheelchairs for PwDs in the region of Northern Thailand. Not all identified actors play an active role to provide wheelchairs in Chiang Mai. An inventory of ATS providers can be found in Appendix XIII and XIV.

Cluster 1 Actor network of FEPDP with the CMDC and FWW

The Foundation to Encourage the Potential Of Disabled Persons (FEPDP)

The Foundation to Encourage the Potential of Disabled Persons (FEPDP) is a legally registered private Thai Foundation originally set up in 1993 in the city of Chiang Mai. The Foundation is dedicated to empowering disabled men and women and providing them with professional skills, as well as with health, employment and dignity. The responsibility of the FEPDP is stated so broad that every assistive technology service can be considered as a responsibility of the organization. The organization depends on sponsors and foreign volunteers CMDC does home visits at clients. Freedom Wheelchair Workshop Freedom (FWW) is the technical facilitator. FEPDP has responsibility for the coordination and finances and keeps in contact with the sponsors and donors. The Chiang Mai Disabled Centre and Wheelchair Workshop are both operated and managed by Thai PwDs. The majority of the wheelchairs are provided through a wheelchair sponsorship program of the foundation.

Chiang Mai Disabled Centre (CMDC)

The foundations office and a number of activities are done at CMDC. There is an information desk for PwDs, where a number of books on disability subjects are available in Thai. FEPDP gives some PwDs the opportunity to run a business at CMDC. There is an Internet shop, a laundry service and a massage service. One staff member is occupied with the administration of the clients and the organization of the home visits to the people that received a wheelchair from FWW.

Freedom Wheelchair Workshop (FWW)

The Freedom Wheelchair Workshop in Chiang Mai is originally set up as wheelchair clinic by the retired English engineer Geoff Thorsby. Today the workshop produces several different types of wheelchairs. The chairs include 3 wheel, all terrain chairs suitable for uneven surfaces; standard 4-wheel folding chairs and special cerebral palsy "buggies". All of the chairs can be made on order to the specific size and disability needs of each recipient with locally available materials. Most wheelchair designs are from Motivation. A wheelchair costs \$250 including \$80 for delivery and follow up. If clients grow out of the chair, or the needs of the client change, they try to make the required adaptations or provide other equipment. The productivity of the workshop changes from time to time, since the workshop serves as a training facility and depends on volunteers. The Workshop has started the production of assistive technology based on PVC tubing, to reduce the costs of their products and increase the productivity.

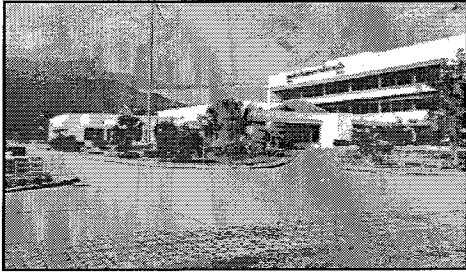


Figure 13. Main building of NCDC.

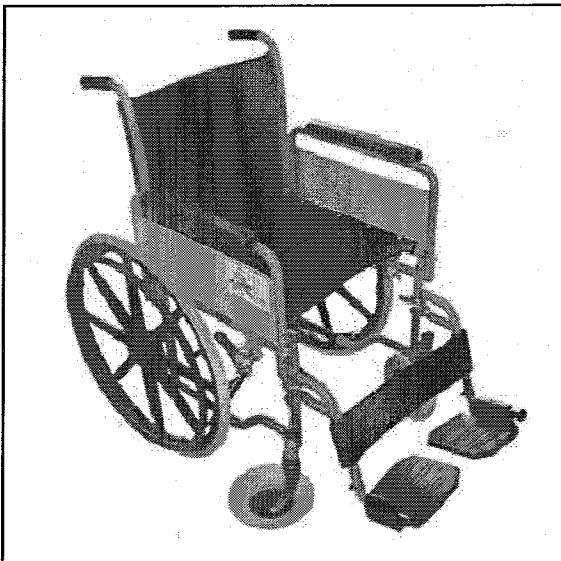


Figure 14. The standard model of the Wheelchair Foundation imported from China.

Cluster 2 Rehabilitation centers with INGO wheelchair providers

The specialized rehabilitation centers Mc Kean and NCDC have most wheelchairs donated by INGOs Wheels of Hope and Wheelchair Foundation. Both organizations import their assistive technology devices from outside of Thailand. The Foundation for Disabled Children in Thailand (FDC) assists by fitting and adapting of the donated devices.

Northern Child Development Center (NCDC)

The Northern Child Development Center falls under the Department of Mental Health of the Ministry of Public Health and was opened in 1994. NCDC is now officially called The Rajanagarindra Institute for Child Development, but is still referred as NCDC. NCDC has a team of physicians, psychiatrists, a special educationist, a psychologist and has a social service to serve the Northern provinces. The service of the Center includes medical treatment and diagnosis, developmental promotion, rehabilitation and counselling. Children and parents can visit the Center and can receive a variety of services. The Center is well equipped for the rehabilitation activities at the Center. The Center provides training for mothers and children. The Community Psychiatry Section is responsible for home visits and acts as a technology supporter for schools, NGOs and community child development centers. NCDC has only limited facilities to adapt or maintain wheelchairs.

McKean Rehabilitation Center

McKean is a general rehabilitation centre for leprosy patients and physically disabled people from other causes. McKean provides hospital based rehabilitation therapy including surgery, physical and occupational therapy, counselling, vocational training, aid to daily living and socio-economic assistance. They train their clients to be self-reliant and are involved in community-based projects outside the centre. The clients are also encouraged to be involved in the gardening and nursery projects and to learn income generation skills. They are trained to do painting, wood sculpture, lacquer ware, clothing manufacturing and other creative artwork jobs. They train and employ cured leprosy patients to make special orthotic devices. After discharge from the wards, disabled people are encouraged to practice independent living in nearby cottages, using the skills learned during their hospital stay. Through the community-based rehabilitation team, McKean is facilitating disabled people in their home areas to improve their situations physically, economically and socially. This team also continues to help people affected by leprosy to live healthily and productively in their own home areas. Mc Kean has a facility where wheelchairs can be produced and serviced. At the time of the research the facility was not used.

Foundation for Disabled Children in Thailand (FDC)

FDC is a Belgian organization with a CBR team in Chiang Mai. The foundation started after the donation of a container with second-hand assistive equipment and other developing supplies. The Belgian organization assists the volunteers in Thailand. The screening team visits children in the rural areas who can not get medical care and education due to the social circumstances of the caregivers. FDC focuses on CBR, education and integration of PwDs in normal social activities. Project coordinator Luc Masschelein is also involved in the promotion of wheelchair basketball and hand bike sports and measures, maintains and repairs wheelchairs during wheelchair donations and home visits.

Wheels of Hope

Wheels of Hope has been distributing wheelchairs in Chiang Mai since 2000, with a donation of 150 wheelchairs. The organization collects and refurbished second hand wheelchairs. They donate them free of charge to disabled people. They work together with governmental and non-governmental organizations involved in medical care and rehabilitation. Since 2001 it has an official registered foundation in Thailand (Pioneers of Hope) to have a legal representative. Sometimes the team members are involved in follow up. Between 200 and mid 2003 they donated more than 3000 pieces of equipment in Thailand.

The Wheelchair Foundation

The Wheelchair Foundation donates wheelchairs to non-governmental or other organizations involved in the assistive technology services. The organizations in the receiving country must be qualified to identify recipients and certified to import humanitarian aid duty free. The receiving organizations take full responsibility for the importation, transportation, and proper distribution of the wheelchairs. The Wheelchair Foundation arranges sponsors and sends photos of every donated wheelchair to the



Figure 15. SIAM wheelchairs displayed in front of the Pharma store in Chiang Mai, across Suan Dock Hospital. The products of SIAM are made for indoor use in hospitals and institutions. The tricycle offers a solution for long distance outdoor mobility.

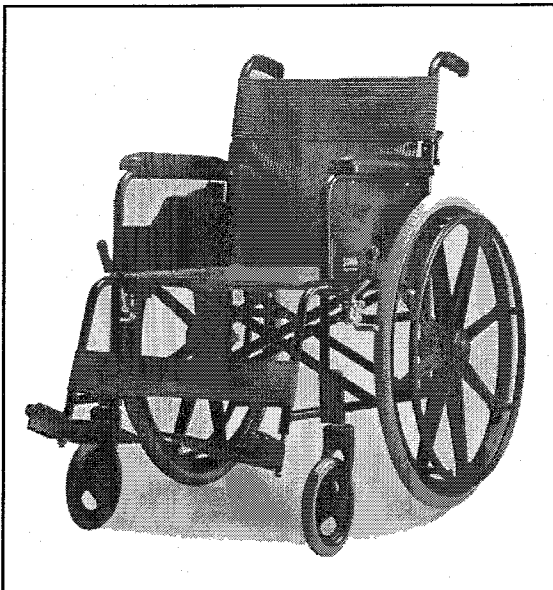


Figure 16. SOMA 150 Lightweight alum alloy wheelchairs produced for elderly, ill and disabled. The foldable wheelchair has a high adjustable backrest. The armrests are not removable, the adjustability of the footrests is limited and the wide seat offers little support.



Figure 17. Singha children's wheelchair with low force brake handles, extra high adjustable footrests and removable armrests. It is one of the few children's wheelchairs made in Thailand. It can be used in urban conditions.

donors. The Wheelchair Foundation tries to establish a long-term distribution relationship. They distribute one model of wheelchair purchased in bulk from China (figure 14, pg.26). The chair is available in various sizes and designed to be the best possible solution in developing countries, but has several plastic parts and air tubes, which makes service necessary and repair very difficult. Accessories and spare parts are locally not available. Their chairs cost \$150 each and are offered free to PwDs in need. For every donated wheelchair \$75 is needed to match and deliver a wheelchair. Between 2000 and 2004 the Wheelchair Foundation donated 3050 wheelchairs in Thailand.

Cluster 3 Local pharmacies

The local pharmacies have connections with the hospitals. They operate as dealers for medical equipment and offer most of the time a variety of brands. Every customer can walk into the store and buy a device. Most products are designed for the hospital market, but some manufacturers offer special measurements. Two general hospitals can provide wheelchairs for patients, but their budget is limited. Therefore doctors also refer their clients to local pharmacy stores.

Chiang Mai Hospitals

The Maharaj Hospital and Nakornping Hospital are two general governmental hospitals in Chiang Mai. Together they have 1,800 beds and serve 414,362 outpatients and 49,200 in-patients each year. The hospital has a technical facility where they maintain and adapt medical equipment. The hospital can provide a limited number of wheelchairs. They also refer patients to the local pharmacy stores.

Pharma Choice and Pharma Store

Pharma Choice and Pharma Store are both local pharmacy stores and dealers in medical equipment. Pharma Choice is a modern store with a diversity of models on the shelves. They sell products of Singha, Soma and a number of brandless wheelchairs imported from Taiwan. Prices of wheelchairs start at \$75. In the region of Chiang Mai they have six stores with one technical repair facility. Pharma Choice can deliver Singa and Soma models specially made to fit the individual patient, but is limited in the choice of accessories. Pharma Store sells the classical hospital equipment mainly for indoor use in hospitals and institutions. They sell products of Siam Limited (figure 15).

Siam Limited

Siam produces mainly stainless steel products for indoor use. They sell their products to local dealers in the cities. Hospitals and institutions and individuals can visit the dealers and buy their products. The product range contains beds, tables, kitchen, laundry and transport cars. Wheelchairs and tricycles seem to be only a minor part of their products. SIAM does not develop or improve their products very much. Their current wheelchairs are hospital models of the Everest & Jennings Company, designed in 1931. Their latest new product for disabled people was made in 2000 on request of one of the dealers in Chiangmai. SIAM has competition from Taiwanese and Chinese companies, because their models look nicer. Customers sometimes request for those models. They can copy those products, or adapt their own products, as long as the customer comes with the ideas and makes the drawings. If drawings are available then products of other designs can be produced.

Singha Medical

Singha medical is a modern manufacturer and distributor of medical equipment. They have a complete range of products for hospital interiors and consumer products. Their products are imported and produced in Thailand. The majority of their products is sold to hospitals and institutions, but devices like walking sticks, walkers and wheelchairs are also sold to individuals. Their wheelchairs are based on the x-bar folding model, but adapted for use in the urban environment. On special request, models can be adapted to the needs of the individual PwD (figure 17).

Soma

Soma is a Thai factory of Karma Medical. The factory is located in Khorat. Their current production capacity is 600 wheelchairs a month. The majority of chairs are made for the export market. Karma Medical in Taiwan designs, manufactures, and distributes life enhancement products for the injured, disabled and elderly. The main focus of products in Thailand is lightweight manual wheelchairs (figure 16). Soma does have the ability to adapt the main sizes of wheelchairs.

3 DATA COLLECTION & ANALYSIS

Cluster 1	Methods of data collection			
<i>Actors</i>	<i>Document study</i>	<i>Direct observation</i>	<i>Direct interaction</i>	<i>Personal interview</i>
FEPDP				Overall information on the different activities and responsibility
CMDC	PwD data and needs inventory from client files	Evaluation assessment and during home visits as volunteer	Evaluation of services by playing and riding with clients during home visits	Idea and concept generation, matching and selection, interviews with volunteers, employees and clients
FWW	Technical data from drawings and literature for problem analysis and evaluation from client files	Technological possibilities, prototyping, production, service and testing during volunteership	Technical data and technological possibilities by production of samples, evaluation of products by self-tests or repaired models	Technical data and technological possibilities, evaluation and monitoring from volunteers, employees and local suppliers

Table 1. Research data collecting methods used for cluster 1.

Cluster 2	Methods of data collection			
<i>Actors</i>	<i>Document study</i>	<i>Direct observation</i>	<i>Direct interaction</i>	<i>Personal interview</i>
NCDC		PwD data collection and needs inventory, technological possibilities during visits at NCDC		Information on all aspects by interview with operating manager of FDC. Mr. Masschelein and members of DCC. Interview on social data collection and needs inventory with SES physiotherapist H. Ott.
Mc Kean		Technical possibilities from product observation		
FDC				
Wheels of Hope	Technical possibilities and production from brochures Website	Observation of donated products		
Wheelchair foundation	Technological possibilities from Brochures Website	Observation of donated products		

Table 2. Research data collecting methods used for cluster 2.

3.4 Research data collection

This paragraph describes how the research data is collected for the actors in the 3 clusters. Table 1, 2 and 3 shows which data collection method is used and who provided the data about the different activities⁴. For practical reasons, the use of existing data is preferred. For the PwD data, many organizations use documents to report their activities and to note down the information and the needs of the PwDs and caregivers. If possible these documents are studied. If organizations do not use documents to register or report their activities, other methods are used. In most cases, a variety of data collection methods is necessary to obtain the necessary information, since the activities and the actors within the assistive technology service are so diverse. Direct observation is used, to see, if and how certain activities are actually performed. If observation is not possible or observation does not give sufficient information then a personal interview is held. Depending on the cooperation of actors or the information required personal interviews are combined with direct interaction. Some of the interviews are focused on the activities of the actor. Research data on the technological data collection and the technological possibilities is collected by interviews and observing the assistive technology devices or direct use or test of the devices. For all the clusters is tried to collect data from the actors and from the PwDs who received service from the actors. This was done to be able to judge the actual activities of the organizations from the position of the facilitators and to have an opinion of the user. In practice not all cluster work together all the time. In the Appendix XV and XVI, the involved actors are mentioned.

Research data collection Cluster 1

The data on cluster 1 is collected during the volunteership at Freedom Wheelchair Workshop. A combination of data collection methods is used to examine the working method and working practice. By a study of the used documents and by interviewing the employees of CMDC and FWW the working method of CMDC and FWW is investigated. Then the actual way of working is examined by studying the client files of CMDC and the order forms of wheelchairs workshop, which contained information about the history of the clients and their current devices. By "joining" the home visits of CMDC at the clients the evaluation and PwD data collection and needs inventory is observed. The client files are updated after the home visits and FWW is informed if technical assistance is needed. During the volunteership at the wheelchair workshop the related activities are observed and products and production are be evaluated. In total four clients are visited and from six clients the wheelchairs history is reconstructed, based on document study and product observation during service and repair at the wheelchair workshop. Table 1 shows which data are collected regarding the activities of the organizations.

Research data collection Cluster 2

Most information on Cluster 2 is collected during interviews with the project coordinator of FDC. He has contacts with all the actors and knows out of experience how the organizations work. He has helped the organization with the technical assistance and CBR activities. NCDC is visited several times, to observe the technical status of the equipment at the facility. Information about the additional information about Wheels of Hope and the Wheelchair Foundation are taken from donation reports. Since the technical facility at McKean is not in use, the last produced model of ATI-Hotchkiss is studied. Two PwDs who received a wheelchair of the Wheelchair Foundation have been interviewed to be able to judge the performance of the cluster from the side of the PwD.

⁴ The data collection is an activity of this research, but also an activity within the research model. Therefore there is made a distinction. Research data collection is to obtain data for this research. The collection of data, as an activity of the wheelchair provision process is referred as PwD data collection or technical data collection.

3 DATA COLLECTION & ANALYSIS

Cluster 3	Methods of data collection			
<i>Actors</i>	<i>Document study</i>	<i>Direct observation</i>	<i>Direct interaction</i>	<i>Personal interview</i>
CM Hospitals				Focused interview with Ms. Wuddhiwong on the role of the governmental hospitals in assistive technology provision
Pharma Choice	Technical data and technological possibilities and device production by studying the brochure PwD data by studying the used files for product orders	General information during visits of several dealers	Sitting and riding in wheelchairs during visits of dealers	PwD data collection, technical possibilities, matching and selection during dealer visit with salesperson
Pharma Store		General information during visits of several dealers		PwD data collection, matching and selection during dealer visit with sales manager and shop assistant.
Siam		Technical data and technological possibilities and device production during company visit.		Interview with the Manufactory Sales Assistant on behalf of director Tanawat Rungs on all aspects and the wheelchair market, product range and technological possibilities.
Soma	Technical data and technological possibilities and device production by studying the brochure			
Singha	Technical data and technological possibilities and device production by studying the brochure	General information during visit of head office	Product test and sample	Information on all aspects during interview with Junior sales manager on behalf of Kuhn Akawut

Table 3. Research data collecting methods used for cluster 3.

Research data collection Cluster 3

Information on cluster 3 is collected by several visits to the dealers and head offices of the manufacturers. Most research data is collected by interviewing the employees at the dealers and by trying the products in some of the stores. Information on the hospitals and their role in wheelchair provision is provided by B.Sc. Wuddhiwong department of Public Health Nursing at Payap University.

3.5 Research data analysis

This chapter explains how the collected research data are analysed. With the diversity of data and limited quantity of data it is not possible to use the statistical methods. The data is collected in sheets, shown in Figure 18. The data collection sheets have been derived from the research model and research instrument. This example represents a situation where all possibilities of division of responsibility and execution of activities are present.

Viewing from top to bottom, the figure shows the phases and activities, similar to the research model. On the right side the actors and their responsibility is mentioned. The left side gives a more precise representation of the indicators.

On the right, the actors are mentioned and the responsibility visualized by toning the box. Technical facilitators are toned dark grey, while the socio-medical facilitators are toned light grey. In an ideal situation they cooperate during the ideation evaluation and monitoring. There the tone is middle. If activities are not executed, but can be considered the responsibility of an actor, then the actor is mentioned but the box is toned white. The example in figure 18 shows, that all responsibility is divided, except for the Testing & training in the Evaluation Phase, where the box is toned white.

On the left side the execution of the activities is indicated. Per activity is a box that represents the execution of that activity. The numbers in the first and third column of cells refer to the indicators and questions of the research instrument (see Appendix IX and X). The cells are toned grey, if an actor in normal circumstances executes the activity, because the activity is embedded in the daily practice of the actor. If an actor never executes a specific part of an activity, then those cells are toned white. For instance the box of PwD data is divided by 10 activities, representing the most important activities. For example code 2, 3 and 4 stand for the investigation of the body structures, functions and measurements of the PwD, which should be collected to determine the size of the wheelchair. The tone of the cells is grey, so the assessment of body structures, functions and measurements are executed in a normal situation.

The numbers on the second and fourth column represent the actual execution of an activity. Where activities are indicated, the cell is marked 1 and toned grey as well. If activities are not executed, the cell is marked 0 and toned white. For code 2, 3 and 4 the activities are marked 0 and toned white, so the activities have not been executed. The body structures, functions and measurements have not been collected. So something went wrong with the execution of the collection of PwD data.

In the data collection sheets, there is no formal connection between the tone of the responsibility on the right, and the tone of the activities on the left. The left side gives no information about the responsibility, only about the execution. Of course there is a connection, because there is a relation between the activities executed and the responsibility.

In cases, where no information was found, the box is not toned and the indicator has mark x. It can also happen that no actor is responsible for an activity, but does execute an activity. This can be in a single case or also embedded in the daily practice of an actor.

By filling in the data collection sheets, the execution of activities is visualized and easy to point out, where activities are executed and where not. The example in figure 18 shows a diversity of possibilities of various situations. Here they are explained more carefully. A look on the left side of the sheet shows that the technological possibilities all the responsibility is divided and the left side shows that all the activities are executed, since all the boxes are toned grey and the cells behind the indicator

3 DATA COLLECTION & ANALYSIS

Cluster	Phase	Problem	Responsibility Actor
A1	Problem	PwD data	social/ medical facilitator
		1 0 6 1	
		2 0 7 1	
		3 0 8 1	
		4 0 9 1	
	5 0 10 1		
	Ideaation	Technical data	technical facilitator
		21 1 26 1	
		22 1 27 1	
		23 1 28 1	
	A2	PwD needs	social/ medical facilitator
		11 1 16 1	
		12 1 17 1	
13 1 18 1			
14 1 19 1			
15 1 20 1			
A3	Technological possibilities	technical facilitator	
	31 1 36 1		
	32 1 37 1		
	33 1 38 1		
	34 1 39 1		
35 1 40 1			
A4	Idea & concept generation	social/ medical/ technical facilitator	
	41 1 46 1		
	42 1 47 1		
	43 1 48 1		
	44 1 49 1		
45 1 50 1			
A5	Matching & selection	social/ medical technical facilitator	
	51 1 56 1 61 1 66 1		
	52 1 57 1 62 1 67 1		
	53 1 58 1 63 1 68 0		
	54 1 59 1 64 1 69 0		
55 1 60 1 65 1 70 0			
A6	Production	technical	
A7	Production	71 1	
A8	Training & testing	social/ medical technical	
	81 0		
	82 0		
A8	83 0		
	A13	Evaluation	social/ medical facilitator
		91 0	
92 0			
93 0			
94 0			
A13	Monitoring	social/ medical facilitator	
	95 x		
	96 x		
	97 1		
98 1			

Figure 18. Example of a data collection sheet.

code are all marked 1. For the activity of PwD data the responsibility is divided, but only the sub-activities corresponding with indicators 6 until 11 are executed well and 1 to 6 are not executed, although the grey tone of the cells of the indicator code tells, that is a normal case, these activities should be executed. During the Matching & selection, the numbers 68,69 and 70 are never executed, as can be seen by the white tone of the cells with the indicator numbers and the white tone and mark 0 in the column left of the indicator numbers. For the indicator numbers 81, 82 and 83 of Training and testing can be said that the responsibility is not divided and the activities are not executed. The box Evaluation represents the situation, where none of the actors claim to do the evaluation and where it does not happen in practice, although they can be held responsible. The numbers 95 and 96 represent a situation where no information is found.

The data can be analysed by comparing the different scores on the activities. Here the clusters are analysed to locate the constraints by examining if all activities are divided among the different actors and by examining if the activities are actually executed. The phases in the model can be executed by different actors or carried out by a single actor. This depends on the rehabilitation strategy and involved actors. In an ideal situation, the actors in a cluster execute all the prescribed activities. In that situation, there are no constraints. If the identification of the network of actors already shows gaps in the execution of the activities there is an incomplete cluster (81, 82, 83). These gaps in the cluster can cause a failure in the assistive technology provision, because not all activities are executed. If the network of actors covers all the activities, then the actors and activities can go wrong due to two reasons. Firstly the actors fail to cooperate in a proper manner and fail to communicate with each other. This can be considered as the constraints in the cluster. This can be seen on the sheets if the responsibility is not divided over all the activities (91, 92, 93, 94) or if information is not transferred (A7, A8). Secondly, the individual actors do not perform their activities. This becomes obvious if activities or parts of activities are not indicated. This can be a structural problem (68, 69, 70) if certain activities are never executed, or an incidental problem, if certain activities are not executed in certain individual cases (1, 2, 3, 4, 5). To be able to give recommendations to the actors, the responsibility of the actors has to be indicated. If activities fail, the capability of executing the activities can be considered.

The cells between the activities and phases represent the arrows in the research model. Not all arrows from the research model are represented, because arrows that originate from the activities of evaluation and monitoring are already represented by the indicators of the evaluation phase and monitoring, because during these activities is checked if there are differences between the current situation and the situation as describes in the problem phase.

PwD data collection and needs inventory demand social and medical skills, while technical data collection and technological possibilities require a technological background. Idea and concept generation and matching and selection are an activity, in which social, medical and technical views should be integrated. Production is a technological activity. Testing, evaluation and monitoring is again an activity where social, medical and technical aspects can be examined. For all the activities it can be said that where possible the PwDs and caregivers should be involved, because they are the main experts in judging, if the activities result in appropriate assistive technology provision. Finally the different clusters and actors were compared, to be able to draw conclusions about the differences in performing activities. In line with the research, this executing or non-execution of the activities can be assigned to the individual actor in a cluster.

After the analysis of the clusters the results can be compared. Clusters can be compared on their overall result and performance in cooperation. Individual actors can be compared on their individual strength and weaknesses.

Cluster 1					Responsibility							
Phase					Actor							
Problem	PwD data		Technical data		CMDC	FWW						
	1	1	6	0			21	1	26	1		
	2	0	7	1			22	1	27	1		
	3	0	8	1			23	1	28	1		
	4	1	9	1			24	1	29	0		
	5	0	10	1			25	1	30	0		
	PwD needs		Technological possibilities				CDMC	FWW				
	11	1	16	0					31	0	36	1
	12	1	17	1					32	1	37	1
	13	0	18	1					33	1	38	0
	14	0	19	0					34	1	39	0
	15	0	20	1			35	1	40	0		
	Ideation	Idea & concept generation					FWW	CMDC				
		41	0	46					1			
		42	1	47					1			
43		1	48	1								
44		1	49	1								
45		1	50	1								
Matching & selection				FWW	CMDC							
51		0	56			1			61	1	66	0
52		0	57			1			62	0	67	0
53		1	58			1			63	1	68	0
54	1	59	1			64	0	69	1			
55	1	60	1	65	0	70	0					
Production	Production				FWW	CMDC						
	71	1										
Evaluation	Training & testing				CDMC	CMDC						
	81	0										
	82	0										
	83	0										
	91	0										
Monitoring	Monitoring				CMDC	CMDC						
	95	1										
	96	1										
	97	0										
	98	0										

Figure 19. Data collection sheet of cluster 1. The sheet shows the execution of activities according to the actors and methods, adapted with the information on the individual cases.

CHAPTER 4 RESULTS

4.0 Introduction

This chapter presents the results of the research of the cluster analysis, actor analysis and comparison of cluster and actors activities. In the first three paragraphs the cluster activities and responsibility of the actors is examined to see if all activities are divided under the different actors and to be able to give recommendations to the responsible actors. This is followed by the results of the examination of the execution of activities by the individual actors, to locate where activities are performed well and where activities are performed less satisfactory. Per cluster a data collection sheet is given, which gives an overview of the performance of activities of the three clusters. During the data analysis first the working methods of the actors and clusters are examined according to the information collected during the interviews. The data are verified and corrected, with the data collected during the interviews with PwD and the observation of actors. In the last paragraphs the clusters are compared to be able to say something about the differences in performing activities. Appendix XV shows the more detailed information on which the analyses are based. Other data collection sheets and a short description of the individual cases can be found in Appendix VXI and XVII. The numbers in-between brackets refer to the code of the indicators and questions of the research instrument in Appendix VIII and IX and are similar to the numbers in the data collection sheets of figure 19, 23 and 24 of the three clusters.

4.1 Results cluster 1

Cluster activities and responsibility

Chiang Mai Disabled Center and Freedom Wheelchair Workshop execute all the activities needed for an appropriate wheelchair provision except for the evaluation phase. This is visible in figure 19, where the entire right part is toned grey. CMDC is responsible for the evaluation, but in practice, neither evaluation nor training is given (81-94). CMDC executes the PwD data collection and PwD need inventory during the home visits at the client's house. Although the standard documents contain all the relevant information, not all PwD data is collected and kept up to date during monitoring (13,19). CMDC is responsible for the PwD data collection and PwD needs inventory and the decisions which assistive technology devices are made or donated. They visit the clients and evaluate if the appropriate aid is given. FWW is responsible for the production and technical service of the products. They are free to come up with new products or improve the current products. Observation and interviews with employees and volunteers resulted in the identification of the following aspects. FWW primary activity is production of assistive technology devices. The clients test prototypes, as if it were normal products. Evaluation and monitoring is done during home visits of CMDC. CMDC does the PwD data collection and the needs inventory of PwD and caregivers. Technical data collection and technical possibilities are examined by FWW. Most of the time FWW executes the ideation phase. Sometimes employees and volunteers from CMDC and FWW work together during the matching and selection. Sometimes employees of FWW deliver new devices at the client's house and adjust it to the clients needs. Although CMDC is responsible for the choice and selection of mobility devices, there is no policy about which devices are provided in which cases. Interviews with employees and volunteers showed that the actual choice depends on the volunteers involved in the process and the availability of second-hand donated western wheelchairs and retrieved wheelchairs after follow up. FWW prefers to build wheelchairs by themselves, but regularly receives requests to refurbish old hospital wheelchairs. FWW executes all maintenance that they think is necessary, although cleaning and maintenance of the tires is the responsibility of the PwD and caregivers.

Actor activities

A study of the drawings, brochures and books at the office of FWW shows a good collection of technical data, from modern western equipment but also from designs made for developing countries. Several publications of David Werner, Ralph Hotchkiss and drawings of Motivation, but also many



Figure 20. Nattapat's feet are not supported by the footrests. This can cause abbreviation of the heel. The harness and table make it impossible to propel the wheelchair by herself, but keep her upper body in a healthy position and make it easy to play by herself.



Figure 21. Waruni uses her feet, like others use their hands. In many Asian houses, all activities are done on floor level. With this low wheelchair, she can move around in the house without restraining her functionality.

brochures and catalogues of American and European ATDs are available in the office of the workshop. Besides that CMDC has the ability to use Internet. The technological possibilities of the workshop are sufficient. The employees make the products with the use of sample products, templates and simplified technical drawings. Changes of the product are often tested by the clients, although the improved products are not always registered in drawings or procedures. All machinery to work with metal, wood, rubber and cloth is available. FWW takes all the important aspects in account during the ideation, but during the matching and selection they do not give sufficient attention to ergonomic aspects and do not involve the PwD and caregivers in choices considering maintenance. The time between product order and delivery is long and the productivity is low. Not all products are inspected after production.

The documents used by CMDC to collect PwD data and the order forms for FWW have a structure to collect all the relevant data. The study of the data files shows that need for body mobility is not registered (13). This can result in limitations of body mobility. The needs inventory is sometimes registered at the forms, but most of the time not the needs are expressed, but the solution of the needs by suggesting an ATD. Information is gathered on the primary caregivers but not on the community support (19). The technological possibilities of FWW are very good, considering the tools, machinery and models. Unfortunately the delivery time of the products is always difficult to estimate. The delivery time is longer than 2 months and the number of produced products is limited as well (39, 40). During matching and selection, most aspects are given attention, but there is no specific attention to the pelvic position and spinal alignment. This can result in the provision of a wheelchair, causing an unhealthy sitting position (51, 52). The need for transport to travel to school or work is not examined properly. This can result in the provision of an ATD that does not meet the mobility needs (62). The ability to clean the wheelchair is not considered (64). Dirt and moist can stick to the wheelchair and cushions can become dirty very quickly. The PwD and caregivers are not given much opportunity to make decisions about technical matters. There is no specific attention to the choice between air tubes or massive tubes (67), while this is normally a choice of personal preference. Massive tires are maintenance free, but give less comfort. CMDC does not look to the overall usability of the ATD, considering the activities and participation of the PwD and caregivers. Since some of the aspects can be in conflict with each other, this can lead to limited usability (70).

Observation during home visits shows that the used forms for data collection are not always filled in or updated properly. Insufficient attention is given to the support of all the body parts and important needs. In some cases insufficient attention is given to the need of accessories or adaptations that are not standard on the form. Without proper details FWW can not make the needed adaptations (2). In many cases, like the case of Nattapat (see figure 20), this results in insufficient support or limited adjustability of the footrest (41, 42). In some cases, the need for activity and participation are not given sufficient attention. Insufficient assessment of the PwD needs for short distance and long distance mobility (5, 15) and body strength to self propel (14) or dependency on others can result in the provision of inappropriate devices for social participation, education and employment (Appendix XVII.I Atipong and Tanyarak). The provision of a low floor model for Waruni (see figure 21 and Appendix XVII.I Waruni) is a good solution considering the indoor cultural behaviour and short distance mobility, but FWW does not have a solution for long-distance mobility. CMDC gives limited attention to the dirt-resistance of the wheelchair. This does not cause many problems, because the design of the wheelchairs itself is very robust. Most models of FWW are very durable, but their appearance deteriorates very fast. The paint blotters of the frame very fast which results in early corrosion of the frame. Sometimes wheelchairs are repainted at FWW, which takes much time. Some end caps that should protect the bearings against dust, get lost. For the CP-buggy and special seating corduroy is used to cover the cushions. The color of this material changes from color if it is exposed to sunlight. Corduroy does not protect the rubber foam against moisture, which makes the cushion vulnerable (63). More attention to the aspects of hygiene can improve the choices concerning the seating. Part of these aspects is related to the environmental settings, but aspect like control over the urogenital system is a body function. Not only do children sometimes wet their pants, but also mature PwDs have sometimes no control over their bladder. Lack of evaluation and technical services causes many wheelchairs to be in disuse or make use very difficult. The lack of provision of tools, instructions on maintenance or technical service results in soft and early break down of air tires (6).

Cluster 2					Responsibility Actor					
Phase										
Problem	PwD data		Technical data							
	1	0	6	0	21	x	26	x	NCDC McKean FDC	WF
	2	0	7	0	22	x	27	x		
	3	0	8	0	23	1	28	x		
	4	0	9	0	24	1	29	x		
	5	0	10	0	25	x	30	x		
	PwD needs		Technological possibilities						NCDC McKean FDC	WF
	11	0	16	0	31	x	36	x		
	12	0	17	0	32	x	37	x		
	13	0	18	0	33	x	38	x		
	14	0	19	0	34	x	39	x		
	15	0	20	0	35	x	40	x		
Ideation	Idea & concept generation								NCDC McKean FDC	
	41	0	46	0						
	42	0	47	0						
	43	0	48	0						
	44	0	49	0						
	45	0	50	0						
	Matching & selection								NCDC McKean FDC	
	51	0	56	0	61	0	66	0		
	52	0	57	x	62	0	67	0		
	53	0	58	0	63	0	68	0		
	54	0	59	x	64	0	69	0		
	55	1	60	x	65	0	70	0		
Production	Production								WF	
	71	0								
Evaluation	Training & testing								NCDC McKean FDC	
	81	0								
	82	0								
	83	0								
	Evaluation								NCDC McKean FDC	
	91	0								
	92	0								
	93	0								
	94	0								
Monitoring	Monitoring								NCDC McKean FDC	
	95	0								
	96	0								
	97	0								
	98	0								

Figure 23. Data collection sheet of cluster 2. The sheet shows the execution of activities according to the actors and methods, adapted with the information on the individual cases.

4.2 Results cluster 2

Cluster activities and responsibility

The rehabilitation institutes Northern Child Development Centre and McKean Rehabilitation Center are fully capable of PwD assessment of their needs within the institutions, but have limited capacity. In Figure 23 this can be seen where all indicators marks are coded 0. As a result of the lack of execution of the PwD data collection and PwD needs, the activities represented by the cells in between the boxes are marked white as well. If no information is collected, it can't be translated into needs. The Foundation for Disabled Children in Thailand assists with CBR-activities at the PwDs house and is capable of giving technical support and training. The ideation phase can be executed by the rehabilitation institutes. The technical data collection and technical possibilities are available with the INGOs, but limited by the diversity of donated equipment by INGOs. INGOs can be considered as the technical facilitators, since they provide the wheelchairs. Since the Wheelchair Foundation and Wheels of Hope do not produce wheelchairs by themselves and do not serve as a technical service facilitator they can not be qualified as a full technical facilitator. It is difficult so say something about the actual technical possibilities. Since the INGOs hold the receiving organizations responsible for the provision of ATD and the distribution, the responsibility of technological issues is not divided clearly. Although NCDC, McKean and FDC can be held formally responsible for these activities, although they do not have the means or the time to execute these activities. Therefore these are marked grey in figure 6, but in practice the activities do not occur very often. Training, evaluation and monitoring only occurs if PwDs are under official treatment of CMDC or stay at a rehabilitation facility.

Actor activities

NCDC and McKean both have the knowledge and equipments for a full medical assessment of the clients for a PwD needs inventory. They both collect data and keep files of their clients, which visit or stay for longer time at the Center, but this is not done during wheelchair donation events. Their capacity is too small to give all clients which receive a wheelchair sufficient attention. Especially during wheelchair donation events⁵, the personal attention for the receiving PwDs and caregivers is insufficient (1-20). The technical possibilities of the Wheelchair Foundation are limited by their product policy on wheelchairs (21-40). The case of the twins Annan and Thawin illustrates that the Wheelchair Foundation fails to meet the individual needs on the PwD. Their model of wheelchair is only of limited use in the rural environment and the models are not adaptable to the individual needs (see Appendix XVII.I Twins) In the case of Kuhn Boon the wheelchair fits correctly and the PwD is satisfied (see Appendix XVII.II). The Wheelchair Foundation has the technical possibilities to deliver appropriate wheelchairs. They do not produce, but import only one standard model wheelchair in various sizes. As a large client, the Wheelchair Foundation can determine which wheelchairs are bought and with their power they can influence the production process and determine what kind of models are produced and if adaptations or accessories must be applied (23). Now they have only limited attention for the individual PwD. The actual matching and selection is a task of the rehabilitation centers. They realized the limitations of the donated wheelchairs, because the majority is for mature people. A disadvantage of earlier donations was the lack of wheelchairs for children. This led to a project sponsored by Rotary Club Chiang Mai and Mc Kean. They produced ATI Hotchkiss models for children, but now the workshop is not used, because there is no staff or funding to operate it. During the donation events CMDC and McKean try to take the ergonomic aspects into account to achieve an optimal pelvic position and spinal alignment (41, 42). Since NCDC has no ability to adapt the donated products, they can only observe if assistive devices fit, but they can not adapt them. They can only adjust the wheelchair if this is a possibility of the product itself and pay attention to the ability to propel the wheelchair (55). The case of Nong Nu shows that most PwD will accept a wheelchair that does not fit properly, but that the usability of a wheelchair is restricted if the chair does not fit properly (see Appendix XVII.II)

Wheels of Hope has more technical possibilities. They have all the machinery and equipment to adapt and repair wheelchairs, but they refurbish and adapt their products in the US. They depend on the donation of second-hand wheelchairs and are therefore limited in the models as well. The donation

⁵ In many cases wheelchair are donated during special events, where a large number of PwDs receive their wheelchairs in a short period of time. These events are often organized to thank the donating organization and attract attention from the local media.

Cluster 3							Responsibility			
Phase							Actor			
Problem	PwD data		Technical data							
	1	0	6	0	21	1	26	x	(CMH)	Singha
	2	1	7	0	22	1	27	x	PC	
	3	1	8	1	23	x	28	x		
	4	1	9	0	24	1	29	x		
	5	0	10	0	25	x	30	1		
	PwD needs		Technological possibilities							
	11	0	16	0	31	1	36	1	PC	Singha
	12	1	17	0	32	1	37	1		PC
	13	0	18	0	33	1	38	1		
	14	0	19	0	34	1	39	1		
	15	0	20	0	35	1	40	1		
Ideation	Idea & concept generation									
	41	1	46	1					PC	
	42	0	47	1						
	43	0	48	1						
	44	0	49	1						
	45	1	50	1						
	Matching & selection									
	51	0	56	0	61	0	66	1	PC	
	52	0	57	1	62	1	67	1		
	53	0	58	1	63	0	68	1		
	54	1	59	0	64	1	69	1		
	55	0	60	1	65	1	70	0		
Production	Production									
	71	1							Singha	
Evaluation	Training & testing									
	81	0								
	82	0								
	83	0								
	Evaluation									
	91	0								
	92	0								
	93	0								
	94	0								
Monitoring	Monitoring									
	95	0								
	96	0								
	97	0								
	98	0								

Figure 24. Data collection sheet of cluster 3. The sheet shows the execution of activities of Pharma Choice in combination with Singha Wheelchairs.

events of Wheels of Hope are comparable with the events of the Wheelchair Foundation, but since no recipients of their wheelchairs were interviewed, it is not possible to come to detailed results. FDC assists in many aspects of assistive technology provision. They assist in monitoring during CBR, give technical assistance and training in wheelchair control and assist during wheelchair donation events. The time and capacity of FDC is insufficient to provide this to all the recipients.

4.3 Results cluster 3

Cluster activities and responsibility

The pharmacy stores Pharma Store and Pharma Choice serve as dealers for wheelchairs for all persons in need of assistive technology devices and act as the socio-medical facilitator, since the ability to service, maintain and adapt wheelchairs is limited. Hospitals do observe the need for assistive technology devices, but according to Ms. Wuddhiwong of Payap University the ability for hospitals to provide wheelchairs is limited. In Chiang Mai, only 2 hospitals are able to provide wheelchairs. The other hospitals refer individuals to a pharmacy store. The hospitals do not play a major role in the wheelchair provision chain. They only observe the needs and refer the client. During visits of the pharmacy stores and interviews with salespersons and managers it became clear that not all pharmacy stores execute the activities of the problem phase. The wheelchair producers do have the technological possibilities to produce wheelchairs, but it differs per manufacturer how much attention is given to the individual needs of the PwD. The pharmacy stores match and select the best model from their stock or catalogue. The attention for ergonomics, adjustability and manoeuvrability differs per dealer and related manufacturer. Since the pharmacy stores execute the whole problem phase and ideation phase, there are no difficulties in the steps between the activities, as can be seen in figure 24, by the grey cells in-between the boxes of the activities. Since there is no formal commitment between the hospitals and the Pharmacy stores the stores can not be held responsible for selling products that do not meet the specific wishes of the individual client. After the delivery of the wheelchair, pharmacy stores do not provide any training or active service. This is visible in Figure 24, where all boxes of evaluation and monitoring are white. Although guarantee on the wheelchairs can be up to 3 years, the initiative on service and maintenance is a responsibility of the client. Dealers do not evaluate or monitor their clients.

Actor activities

During visits of the Pharma Store, the staff does not always pay attention to the PwD needs and they do not collect PwD data. Pharma Store does not inform the client about the technical possibilities. They only emphasize the durability of their products, and do not consider the limited outdoor usability. Since the market of Pharma Store is focused on the indoor hospital market, they only look at the maximum measurements and average medical situation of the majority of the wheelchair users (2, 3, and 4). Siam feels the competition for cheap wheelchairs from Taiwan and China and is willing to produce other models as well, but is not capable of designing competitive models for the market by themselves (21, 22, 23, 31, 32, 33 and 34). They do not inform their dealers about the possibilities of the company. Since Siam only produces a limited number of models, all their wheelchair models can be found at the dealers. There is not much the Pharma Store can do to match and select and appropriate wheelchairs. Siam operates on a market, where not the individual consumer and user decide, but where budget limitations force institutions and hospitals to buy products suitable for all users (41, 42). The demands of these products are often that all patients should be able to use them. This results in oversized products, for temporary indoor use. For that purpose, the wheelchairs are good. The products are all made of high quality stainless steel, with skai and rubber seating and massive tires. This is done to meet international standard of hygiene in hospitals (64). The products are durable (65), but not appropriate for use in rural conditions. The use of stainless or achromatized steel makes them heavy (58, 59), but easy to clean and maintain. Most PwDs in a standard hospital do not sit in a healthy ergonomic position, since there is no side support and footrest can not be adjusted (51, 52). Most wheelchairs do have a seating with rubber foam in it, to prevent skin problems (53) but this is only sufficient if the time of the wheelchair use is limited. Arm supports are padded and most chairs are made in such a way that there is no need for extra padding or protection for impact reasons (61). The classic models are made to push forward, so the configuration of the wheels is not optimal for propulsion by the PwD (54, 55). The angles of the seat and backrest are also chosen for a



Figure 25. Demonstrating a wheelie in a Singha Sports model. Kohn Kean 2004.

passive short time indoor use (56). Although the material is very durable, the wheelchair configuration and the wheels and tires make the wheelchair inappropriate for use in rural areas (57, 60). Since the wheelchairs are not adjustable, there is no need for tools to adjust. Most wheelchairs are durable as well, so tools for maintenance are only necessary if parts have to be replaced (65, 68). The spare parts can be ordered at the dealer and some dealers offer technical services themselves.

Pharma Choice has a better collection of models and the client is assessed more carefully (Fig. 7; 2,3,4,8) but the personal data, social situation and activities and participation are not examined very carefully either (1,5,6,7,9,10). Pharma Choice is aware of the technological possibilities of their manufacturers, but can not always give accurate attention to ergonomic aspects. Their means are limited by the wheelchairs in the store and the documentation of the wheelchair manufacturers. Besides the classic hospital chairs, Pharma choice also sells products of Soma and Singha. Soma produces mainly wheelchairs for elderly and ill people, who can not walk by themselves. Soma's international partners produce modern wheelchairs for PwDs as well, but the employees of Pharma Choice were not aware of that. Some of the models of Soma that were available in Chiang Mai can be used by PwDs as well, if use is limited to urban areas (57). Although the wheelchair configuration and position of the seat and backrest are not optimal (51, 52, 54, 55), the light weight of the alum alloy frame makes it much lighter to manoeuvre the wheelchair (figure25). Besides that, the adjustable footrests are optional to give sufficient support to the feet (41) and the size of the caster wheels is much larger for better comfort (60). The models of Soma look good (69), but their models can not be adapted to the individual needs. Singha is capable of producing and fitting wheelchairs to the individual needs of the PwD. They try to modernize their products regularly, but also for urban conditions. Singha informs their dealers very well about the technological possibilities of the factory (31-40). During the assessment, they focus on the measurements of the PwD and the need for body support (2, 3, 4 and 14). No attention is paid to the adjustability of the supporting parts during the lifetime of the wheelchair. The adjustability of the foot rests that are adjustable seems sufficient, but not all models are adjustable.(42, 43). Singha delivers wheelchairs from Alum alloy as well and their models are almost maintenance free. The materials are not sensitive for corrosion and bearings are good protected against dirt (46, 47). The durability of certain in mould manufactured parts can be discussed, because once they brake down, they can not be fixed. Since spare parts are available at the dealer, this does not have to be a problem (48, 49). Singha is capable of producing a variety of wheelchairs and modern wheelchairs. Unfortunately none of their models is totally designed for use in rural conditions. In those conditions the in mould parts can wear out very fast. Singha informs their dealers about the accessories and adaptable measurements of the chairs. A lot of aspects of attention are embedded in the wheelchair already, and optional choices and individual measurements should guarantee a good fitting wheelchair for the individual. Eventually the quality of the assessment depends on the skills of the sales persons. Some models of Singha are appropriate for active use as well (54, 55) and appropriate for sports activities. Interviews with salespersons show that they do not have much awareness of ergonomics aspect of PwDs (51, 52, 53). They do take the shoulder/pushrim orientation into consideration, because different sizes of wheels are available (54). Detailed information on chamber angles or seating angles is not an option (55, 56). Salespersons are aware of the usability wheelchairs outside, but can not offer a solution for individual use in more hilly areas. They advise to buy a foldable wheelchair, so it can be taken along in a car. There is not much attention for safety matters or prevention of skin problems and protection against damage during spasms (61, 63). Since the assessment only focuses on the measurements, it is not possible to consider if the wheelchair will be usable considering the activities and participation. Attention of special cushions is only given, if the customer comes in with specific seating problems.

4.4 Results cluster comparison

All clusters have difficulties in activities where social, medical and technical data should be integrated. There is little cooperation between the facilitators and the PwDs. In none of the cluster the PwD and caregivers come in direct contact with the actual manufacturer of ATD before the production of the devices. In cluster 1 and 3 social or medical facilitators have the responsibility for the ideation. Cluster 1 gives the best attention to the individual PwD. They are in most cases able to adapt the wheelchair to the measurements of the PwD to make it suitable for the PwD and appropriate for use in the rural environment. Cluster 2 is restricted by the diversity of the donated models and limited time. In cluster 3 the execution of the ideation depends on the product range of the pharmacy stores and the ability of the salespersons to match and select an ATD with the information provided by the manufacturer.

All clusters have difficulty in realizing appropriate ergonomic seating. In cluster 1 and 3 the awareness of the importance of a good body position is limited, while cluster 2 is restricted by the donated models and time, to pay attention to these aspects.

The comparison of the clusters shows that all the clusters fail to evaluate within one month of the delivery. None of the clusters evaluates the wheelchair delivery in the short term. In all clusters the attention for technical issues on the long term is insufficient. Cluster 3 does not evaluate or monitor at all. In Cluster 1 and 2 monitoring is often done by social or medical facilitators, who have limited technical skills and means to improve the assistive technology devices. In most cases PwDs have to learn how to use their wheelchair and have to do maintenance by themselves.

4.5 Results actor comparison

A comparison of the technical facilitators shows that the wheelchair manufacturers in Thailand all have the technological possibilities to produce appropriate wheelchairs for PwDs. Only FWW in cluster 1 produces wheelchairs for use in rural circumstances. The others are only capable of producing and supplying wheelchairs appropriate for urban conditions. FWW has most contact with the PwDs since employees sometimes visit PwDs for maintenance, but the frequency of contact is low. They try to improve their products, but this process goes very slow. All their models are appropriate for the rural circumstances and can be made suitable for the individual.

The Wheelchair Foundation and Wheels of Hope are not manufacturers but buy new models or refurbish second-hand models. They work on a large scale and do not pay sufficient attention to the need for individual adaptations to the needs of the PwD. They make local organizations responsible for the matching and selection. The usability of their models in rural circumstances is limited and the local organizations do not have much ability to adapt the wheelchair to make it suitable for the individual PwD.

Pharma Choice and Pharma Store depend on the model range, options and accessories of their manufacturers. Their attention to the PwD differs per manufacturer, since the manufacturers provide different information on how to approach a client. Siam concentrates on the indoor hospital market, while Soma and Singha also make wheelchair for use in urban areas. Singha has the most options to optimize the suitability. None of their models are specially designed for use in rural conditions.

NCDC and McKean have the best medical and social knowledge, but the attention to the individual PwD is limited by the available time during donation events. CMDC uses a good method for PwD data collection and needs inventory, but is limited in the ability to translate the needs into a suitable product. Most home visits are socially orientated.

CMDC and McKean do keep contact with regular visitors, but more remote clients do not receive much attention. FDC can assist in many activities, but is also limited in its capacity.

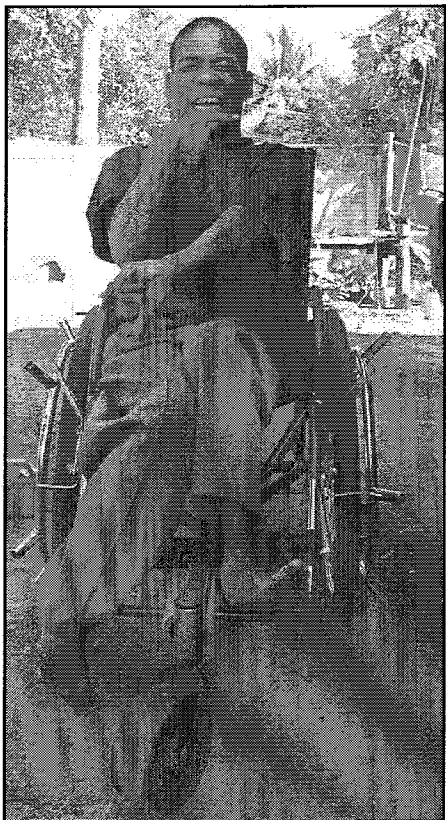


Figure 26 and 27. Freedom Wheelchair Workshop is the only workshop which makes wheelchairs for children and adults, designed for use in rural circumstances. Since they can produce complete wheelchairs, they can adapt the model to the wishes and needs of the individual client. The model on the left has special pushrims for extra grip. The model on the right has extra padding around the footplate, to prevent harm during spasms. The sitting position of both clients can be improved, since the pelvic seems tilted to the back.

CHAPTER 5 CONCLUSIONS

5.0 Introduction

The conclusions and recommendations should provide the answers to the research question. The research is performed to enable giving suggestions for improvement of the assistive technology service for the provision of wheelchairs. This chapter concludes what the consequences are of the way in which the activities are executed, as described in the previous chapter. First the constraints concerning the activities and responsibility per cluster are discussed to enable giving recommendations to improve the cooperation of actors. In the next chapter conclusions are drawn per actor, to be able to give recommendations to the individual actors. The last paragraph describes the conclusions on the clusters and actors comparison to see if there are other possible ways of cooperating to improve the overall performance.

5.1 Conclusion cluster 1

Cluster activities and responsibility

The wheelchairs that are produced by FWW and provided by CMDC are suitable for the rural environment (figure 26 & 27). With the current products, FWW can offer almost all the ATDs for better mobility, except for long-distance mobility. Although the assessment forms contain the most important information, closer cooperation between CMDC and FWW during the data collection and needs inventory would make it easier for FWW to make a wheelchair that meets the needs of the PwD and caregivers. Now FWW often depends on the information and photos of CMDC and can not obtain a proper understanding of the actual needs of the PwD. There is no procedure for actual physical fitting and FWW does not get in contact with the PwDs, which makes it difficult to imagine how accessories and special adaptations should be made. Since the frequency of evaluation of wheelchairs and the monitoring is low, the condition of the wheelchairs and the usability is a point for improvement.

Since CMDC and FWW are both actors under supervision of FEPDP, the policy of FEPDP determines the deviation and cooperation during the activities. CMDC and FWW try to help in so many fields that many activities do not get sufficient attention for a proper execution of activities. CMDC is responsible for the monitoring of the wheelchairs but has no technical skills to examine, maintain or adjust the devices. In theory CMDC decides which products will be made, but in practice, the volunteers of FWW make the decisions.

The organizations have insufficient skilled employees. CMDC has no capable medical trained staff members that can fully examine the PwD. They can provide basic massage and physiotherapy, but are not specialized in rehabilitation therapy. In some cases a wheelchair was prescribed, while this was not an optimal device for the PwD. In case of Atipong and Tanyarak it would be better if more effort was made in the education of the parents and referral to other institutions (see Appendix XVII.1). Because they can not fully judge the situation or see the actual potential of the PwD in question, they do not always inform the parents about other services or institutions and sometimes fail to prescribe the appropriate assistive technology devices. In cases where the PwD is able to move around in the house it is often better to provide a device for long distance transport. Since the current employees are already occupied with their current activities, there is little time for more cooperation. Because the organization heavily depends on foreign volunteers, the quality of their services changes from time to time. This makes the organization vulnerable. Volunteers are often considered as skilled persons, while that is not always the case. Since the education on rehabilitation practices of the employees is limited, it is difficult for CMDC to give good advice to clients and choose appropriate assistive technology devices. Only at the time of delivery the suitability is sometimes evaluated, but action to improve the situation often occurs much later or does not occur at all. Due to the long interval between home visits and the passive attitude of FWW considering the improvement of models and adaptations to the individual needs, the benefit of the home visits is often for a short period.

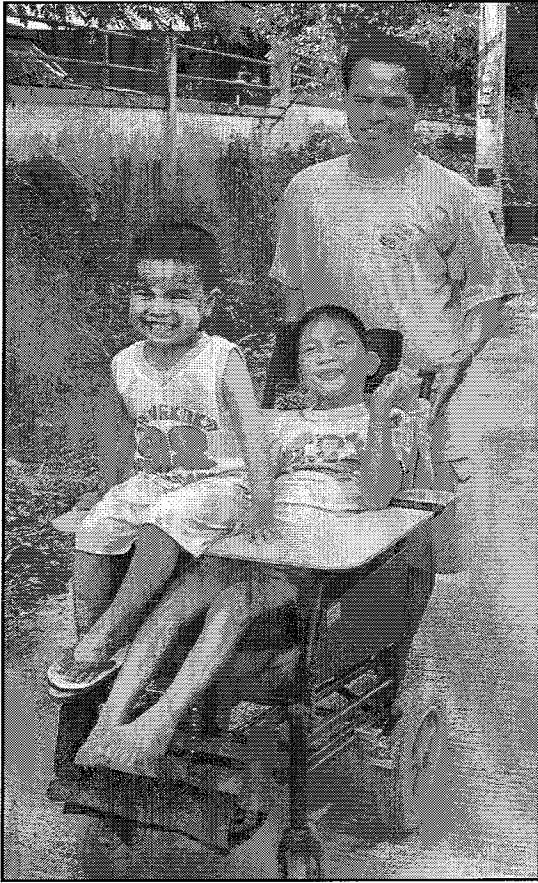


Figure 28. Tidaphon received a refurbished wheelchair with adapted headrest, tabletop and belts. Despite the fact that the chair is still too big for him, he, his father and little brother have great fun riding around.



Figure 29. Bantitaa enjoys riding in her CP-buggy. Although the seat is very comfortable, the footrests are a point of improvement. The height of the seat is a concern of many caregivers and makes it difficult to interact with other children.

Actor activities

Small mistakes in the actor activities can have great consequences for the usability of the provided wheelchair. The aspects that do not get sufficient attention are mentioned here. Limitation of the body mobility limits the freedom of the child to move and make contact with others. While many PwDs are already looked upon with abstention, further isolation from others should be avoided at all times. It is important to involve the family and community in the social life of PwDs. CMDC has no structural CBR activities in the sense that it stimulates or promotes local health workers or organizations to get involved in the social participation of PwDs. If no information is gathered about the community support, it is difficult to give the help that is needed mostly. It is useless to give someone a wheelchair, if that person can not propel the wheelchair by himself and nobody is willing to help him move around. On the other hand, it is useless to make someone a wheelchair, if they can obtain an appropriate wheelchair through other local organizations as well (see Appendix XVII.I Twins). Of course the impulse to go to other organizations as well will come if organizations work very slow and delivery time is long. The limited number of produced products by FWW has only a limited impact on society, but all the help that is provided contributes a little bit to the improvement of the position of PwDs. Not all aspects of ergonomics are fully understood by CMDC and FWW. Insufficient attention to body support, the pelvic position and spinal alignment shows that the knowledge about sitting ergonomics is insufficient (figure 29). This can cause wheelchairs that force a PwD to sit in an unhealthy position. Other unhealthy situations can occur if the wheelchair is difficult to clean. When cushions are not easy to clean, they can become a source of infection and skin problems. The rubber foam and covers made of natural material is hard to dry and will get mouldy. On the other hand not all the dirt resistant materials are comfortable in a hot and moistly climate. If PwDs wear short sleeves, materials can get sticky. The choice between dirt resistance and higher maintenance can be made best by the PwD and caregivers themselves. A similar discussion can be held about the tires. The majority of the wheels have air tires. They are easy to buy locally but need regular maintenance. Massive tires do not need maintenance, but are also less comfortable. Some conflicting aspects lead to limited usability of ATD. The tabletops provided on the wheelchairs are very useful during indoor activities like education, playing and eating. Unfortunately they limit the mobility of the arms and make it difficult to touch the push rims and use the brakes. Not all tables can be removed by the PwDs themselves, which makes them dependent on others (figure 28). In other cases, the overall use of the wheelchair is limited. In case of Atipong and Tanyarak the wheelchairs are not the best solution, since they do not help to make them mobile. They are still dependent on others for transport and the wheelchairs are only used for short distances.

A strong aspect of FWW is the technological possibility to produce appropriate wheelchairs, suitable for the individual client. Their basic concepts are usable in the rural environment. A weak point is that in practice CMDC and FWW have great difficulties in achieving an optimal ergonomic seating position and sufficient body support. The employees are not fully capable of assessing the needs of every individual PwD. The contact with the PwDs and caregivers is not intensive enough to be able to ascertain and solve related problems on the short term, resulting in a limited usability of the provided devices.

5.2 Conclusion cluster 2

Cluster activities and responsibility

Despite the fact that Cluster 2 has all the skills and knowledge for an inventory of optimal needs, it is not capable of providing appropriate assistive technology. The biggest problem seems to be the limited capacity of all the institutions. They can not give sufficient times to the individual PwDs. Wheelchairs are donated in a hurry and not enough time is taken for a proper evaluation and final adaptations. Although NCDC and McKean have the skills and knowledge to execute a needs inventory, their time and capacity to do this is limited. Their quality of work depends on the quality and diversity of wheelchairs donated. The policy of the Wheelchair Foundation neglects the importance of technical data collection and limits the technical possibility to meet the needs of the individual PwD. Therefore the wheelchairs donated are only of limited use. The Wheelchair Foundation holds NCDC and Mc Kean responsible for the matching and selection of PwDs and wheelchairs, but the limited time and staff can not give the needed attention to the individual PwD. Even if they would have the time to hold a better assessment, it would be impossible to realize a good match between PwD and wheelchair for all the PwDs, since they do not have the ability to get involved during the decision

making of what kind of wheelchairs are ordered for a donation, because this is decided in advance by The Wheelchair Foundation. This results in the donation of wheelchairs that do not fit optimal and of which the use in the rural environment is limited, since the current models can only be delivered with a limited number of different sizes. NCDC realizes the limitations of donated wheelchairs, but they do not have the technical facility to adapt the wheelchairs to the individual needs and the policy of the Wheelchair Foundation limits the possibilities to ask for adapted wheelchairs. Monitoring is only done in the wider medical perspective as long as PwDs use the regular services of NCDC or McKean or during CBR. These visits do not focus on the assistive technology.

Actor activities

Due to the limited time and capacity, only the wheelchair provision of clients that visit NCDC can be evaluated and monitored. In some cases PwDs will learn how to use their wheelchair during rehabilitation therapy. For the majority of the PwDs this is not the case. The same holds for visitors of McKean. Although McKean has a workshop as well, the workshop is not used. Spare parts can still be obtained, but service or adaptations is not possible. Clients are monitored as long as they receive help at the rehabilitation institutions and during home visits of CBR.

The Wheelchair Foundation could improve the benefits of their donations by giving more attention to the appropriateness of their donated wheelchairs. Attention for the individual needs of the PwD and the need for local maintenance of wheelchairs would reduce the chance of limited use of models due to bad fitting or early decay. If tools for maintenance and injection-moulded parts and tires are available, then their wheelchairs can be kept in better condition. The availability of accessories like head-supports and cushions would make many wheelchairs more appropriate, without changing the basic model. Since the donated models of the Wheelchair Foundation are all similar, the amount of spare parts that should be donated can be limited.

FDC can help in many fields, but has limited capacity. The limitation in time, available for the matching and selection of wheelchairs makes it difficult for them to give good advice.

5.3 Conclusion cluster 3

Cluster activities and responsibility.

Some PwDs are sent to a pharmacy store by a hospital, since only two hospitals play an active role in the provision of wheelchairs. The other hospital refers the clients to Pharma Choice or Pharma Store, since they are dealers of Siam, Singha and Soma wheelchairs. The hospitals can be held responsible for the advice they give to their clients like where to go to purchase a good wheelchair. If no special medical care is needed, hospitals refer clients to pharmacy stores, since it is the easiest way to obtain a wheelchair. There is limited contact between the hospitals and the dealers, since most hospitals have their own technical service staff. None of the actors mentioned is involved in training of the PwDs in wheelchair use, or evaluates the actual use of the wheelchair. There is not much to say about the contact between the PwDs and the technical service of the pharmacy stores, because the interviewed PwDs have no contact with the pharmacy stores, where they obtained their wheelchair. Most wheelchairs do have guarantee, but costs of maintenance are not included. Pharmacy dealers do not depend on the sale of wheelchairs to individuals alone, so their knowledge on how to deliver a good fitting wheelchair often depends on the information about the technical possibilities and assessment forms provided by the wheelchair manufacturer. The sales persons and managers are not always well informed on the technological possibilities of the manufacturers. None of the models that the manufacturers deliver is specially designed for use in rural conditions.

Actor activities

Siam still concentrates on the hospital market. Their products are inappropriate for individual PwDs since they do not fit the majority of the users. Their models are made to be pushed, which makes the PwD more dependent on others. The wheelchair configuration makes the models heavy to propel. The models of Soma have similar difficulties, but due to the use of alum alloy material, the models are much lighter. Singha pays the most attention to the individual needs of the PwD and even sells wheelchairs specially made for children and active mature PwDs. In all cases, the skills and

knowledge of the salespersons determine whether the best wheelchair is chosen out of the available models and options. Pharma Store is restricted by the limited choice and focus on the indoor hospital market. At this moment, they can not help individual PwDs to obtain an appropriate wheelchair. Because Pharma Choice has a better collection and is dealer of Soma and Singha, they can offer much better equipment. They can provide suitable wheelchairs for PwDs, if the measurements would be taken correctly. Singha has the technological possibilities to offer accessories, but the special attention to individual accessories or options on special seating remains limited. An advantage of the models offered by Pharma Choice is the use of alum alloy in the frames of their wheelchairs, which makes them much lighter and therefore much more manoeuvrable. For PwDs that already know what kind of wheelchair they want and what their personal needs are, the service of Pharma Choice can be sufficient for PwDs that need a wheelchair for use in urban areas. Pharma Choice has no appropriate ATDs for use in rural areas.

5.4 Conclusion actor and cluster comparison

All knowledge to provide appropriate wheelchairs is available in Northern Thailand, but facilitators do not have sufficient capacity or do not take the time to combine the knowledge to achieve appropriate assistive technology provision.

Although 80% of the PwDs live in the country, the majority of wheelchairs available in Northern Thailand is not designed for use in rural circumstances. Most of the time wheelchairs made by national manufacturers or wheelchairs imported by INGOs are designed for use in urban areas. FWW has designs and the ability to make suitable wheelchairs for use in rural circumstances and can adapt wheelchairs to the individual needs. They have only limited capacity. More production capacity is available at the larger wheelchair manufacturers.

All clusters can improve the cooperation between social, medical and technical facilitators and interaction with the PwDs and caregivers. PwDs and caregivers should have the opportunity to tell their own needs and preferences. Medical facilitators should be able to make suggestions for personal adaptations and accessories. Therefore they should also have the ability to make decisions about those aspects during the matching and selection of ATDs. In most cases these abilities are limited because the distance between the actors is large and they do not have a shared responsibility.

Although the regional rehabilitation centers have medical and social knowledge about rehabilitation, there is a shortage of time and capacity to give sufficient attention to the PwD during the process of ATD provision. This results in the provision of wheelchairs that do not meet the individual needs of the PwDs. The limited cooperation between medical and technical facilitators and limited interaction with the PwD and caregivers makes it difficult to make the wheelchairs suitable for the PwD. Limited adaptations of basic measurements, limited choices of accessories and limited adjustability of footrests and wheelchair configuration all reduce the mobility and usability of the provided wheelchairs. To achieve a better suitability for the wheelchairs, more attention should be given to the ergonomic aspects of wheelchair provision. More cooperation between the different facilitators and PwDs can improve this situation.

There is little time taken for training of PwDs in wheelchair use and PwDs do not have the ability to test their wheelchairs. Short term evaluation does not occur and monitoring only happens in a limited number of cases. Therefore the chance that problems related to the inappropriateness of wheelchair are detected and resolved is very small. This can lead to more problems or disuse of wheelchairs. Only if regular contact with PwDs and caregivers remains, problems can be identified and followed up by action to prevent further problems and improve the situation. Maintenance of wheelchairs is often considered as the responsibility of the PwD and caregivers, but they must be trained in recognizing inappropriate situations and they have to be informed about the possibilities to adjust their ATD or receive service from technical facilitators.

5.5 Overall conclusion on ATS in Northern Thailand

Considering the definition of ATS, the conclusions of the previous paragraphs can be divided under the sub-definitions. Here the most important conclusions are described in line of the sub-definitions.

Needs Evaluation

All clusters can still improve the needs evaluation. In most cases the needs evaluation is done with limited time and capacity and only a limited number of PwDs are monitored after the provision of wheelchairs.

Technical services

The number of technical services of people who can design, fit and customize wheelchairs to the needs of the PwD and caregivers is limited. If something goes wrong with the provision of wheelchairs, there is little opportunity to further adapt or adjust the wheelchair. Maintenance is often the responsibility of the PwD and caregivers and the intensity of monitoring is low.

Financial services

PwDs which receive a wheelchair from cluster 1 and cluster 2 do not have to contribute to the expenses of the provided devices. PwDs that purchase a wheelchair from a pharmacy store have to pay for the device themselves. Most donated wheelchairs are sponsored by foreign donors or INGOs. No conclusion can be drawn on the efficiency or effectivity of these aspects, since in none of the cases the finances seem to be a restriction for wheelchair provision.

Coordination

None of the organizations is able to organize a complete coordination of needed services. Only the rehabilitation centers of cluster 2 can offer the full scale of medical rehabilitation services, but they depend on others for technical services. Pharmacy stores and CMDC have insufficient knowledge to coordinate and can only give suggestions to PwDs and caregivers to seek help at other organizations. For PwDs and caregivers this results in the ability to seek help at several organizations. This can result in the overprovision of certain aid for PwDs who are already known by the organisations, while other PwDs that live in remote areas do not receive any help at all.

Personal training

There is little attention for training of PwDs and caregivers on the use of ATD and need for maintenance, after or during the provision of wheelchairs. Most PwDs have to learn how to use the ATD by themselves. This limits the usability of most wheelchairs, because training improves the confidence and manoeuvrability of the PwD.

Professional training

The way in which the activities are executed show that there is a need for more training of persons involved in ATS. There is only a limited number of specialists with limited time, knowledge and practical skills. Although most knowledge and skills are somewhere available in the different clusters, none of the clusters is fully capable of providing a complete ATS service.

CHAPTER 6 RECOMMENDATIONS

6.0 Introduction

In this chapter recommendations are presented on how the assistive technology services can improve the provision of wheelchairs for persons with a disability in Northern Thailand. Recommendations are given per cluster and actor because the data on the different clusters and actors varies. Attention is given to the responsibility and actual execution of activities. Based on the cluster- and actor comparison recommendations are given to improve the provision of wheelchairs as a whole, followed by a reflection on the definition of ATS. This is done so it is possible to place this research in the wider context of ATS. In the last paragraph the research is evaluated. The research model and execution of the research is discussed and recommendations on future research are given.

6.1 Recommendations cluster 1

Closer cooperation between FWW, CMDC, PwD and caregivers

FWW has two strong activities. Since FWW is the only workshop that makes wheelchairs appropriate for use in rural circumstances, it can enforce its position if it concentrates on those activities. Moreover FWW is capable of making special seating systems and accessories. These activities can be further improved if more attention is given to the assessment, evaluation and monitoring. Now this is done by CMDC. If FWW becomes partially responsible and these activities will be executed together with the PwD and caregivers, employees can learn from each other. Employees of FWW will get a better understanding of wheelchair use in practice and CMDC will get better insight in the technological possibilities of the workshop. If the decisions on ATD are made during the home visits in cooperation with the PwDs and caregivers, there is a smaller risk of losing or missing important information on the PwD needs. It is also recommendable to ask the PwD and caregivers about other organizations that can provide community support, to be able to concentrate on the help that is actually needed and prevent oversupply of products.

Improvement of efficiency of activities during home visits

The models of FWW are all appropriate for use in rural circumstances. Their models can still be improved and the speed of improvement can be improved by a better organization of the contact with the PwD and caregivers. This can be done more efficiently if an employee of FWW would join during the home visits of CMDC. Problems can be detected sooner and products can be improved faster. Closer cooperation between CMDC and FWW with the actual assessment of the PwD can improve the Ideation phase, because they understand the relation between the measurements of the PwD and the needed measurements to make a fitting wheelchair and can immediately judge if proposed accessories and changes from the standard models can be made. Depending on the needs and wishes of the PwD and caregiver, the need for maintenance can be minimized. This can result in a decrease of technical services, but not in a decrease in social or medical monitoring. The interval of home visits of CMDC is so limited that the benefits of massage and basic physiotherapy are doubtful. More frequent visits or more intensive contact with the PwD and caregivers can improve the social service of CMDC. Technical service for maintenance can be improved by always taking an employee of FWW on home visits. The efficiency of the home visits can be much improved, if PwDs are contacted before the visit and asked to inform FWW on the status of the current wheelchair. In that way FWW can decide if an employee has to come along for technical service and take the appropriate tools and spare parts. They can help more efficiently and signal weaknesses of the products much faster. This can be used for more adequate adjustment, adaptation and product improvement. Another option to improve the maintenance is to let the PwD and caregivers contribute in the maintenance. This can be a financial contribution, but also a compulsory to maintain the wheelchair. If ATDs are provided for free, it is very difficult in the Thai culture to reject a given device. If people have to make a contribution, this is much easier and people will become more aware of the value of the ATD. If PwDs and caregivers can not contribute to the maintenance then it can be considered to involve the nearest bicycle repair shop in the maintenance and service. The assessment files can be expanded with a sheet on technical status of the ATD. Then CMDC can control the social status of the PwD and the suitability of the wheelchair.

Specific attention to body mobility needs, can prevent that PwD are tied up in their ATD (13). It is important to fix only those parts that need to be fixed to maintain a healthy position. All other fixations only restrict the body mobility of the PwD. A PwD should be able to reach out as far as possible to be able to function as good as possible and to be able to make contact with others. For the current models, this means that the tabletop and toy-bar on the CP-buggy must be removable and that the harnesses and fixation belts should be minimized to a pelvic belt and a thorax belt.

Improvement of technological possibilities

A target of FEPDP is to create independent PwDs and therefore stimulates employees to study and become independent. On the other hand FWW and CMDC depend on their skills for the execution of the job. There is no system of giving knowledge to successors. Therefore the organization is very sensitive to changes of staff. The change of volunteers adds to the problem of changing technological possibilities and the resulting quality of production. The staff, employees and volunteers of FWW change from time to time and employees and volunteers often need training. If there is no permanent teacher or manager to oversee the production and teach the necessary skills, the production will slow down and eventually stop. If employees only learn about metal production, they can not be expected to make an appropriate wheelchair on their own. Therefore they need to have basic understanding about ergonomics and rehabilitation assessment. If the employees learn how to make and read technical drawings, they can build a wheelchair without assistance from a manager. The drawings can be obtained from Motivation. These skills can be learned at CMDC, since technical drawing software and computers are available. A better understanding of seating ergonomics can prevent an unhealthy seating position. A lot of information about seating ergonomics is available in the office of the wheelchair workshop, but it is not used in practice. A study of the available information by the employees of FWW and CMDC can improve the knowledge and make them aware of the importance of ergonomic aspects (see Appendix VI). Since the employees of FWW are entitled to follow English and computer lessons at CMDC and a lot of the information is available in English, the lessons on these subjects can be combined with the English lessons. Some publications are also available in Thai and can be used to inform visitors of the centre and clients of FWW. The aspect of durability and hygiene of the cushions and covers can be improved in two ways. The wheelchairs can be made dirt resistant, by using dirt resistant and water proof materials like nylon, skai or leather, to prevent dirt and moisture to penetrate in the material. Another way is to make the parts detachable, so the covers and cushions can be taken apart for cleaning. Consider the use of dirt resistant material or material that is easy to clean. Here it also deserves recommendations to show the PwD and caregivers how the parts of the wheelchair should be removed and cleaned, so they learn how and why this is important. The PwD and caregivers can be more involved in the choice and selection of technical aspects. PwD and caregivers can be given the choice on which tires they want. If they know how to maintain them, it is better to use air tires. If they do not have the technical skills, it is better to use massive tires. PwDs and caregivers should be informed about the priorities of the choices to be made during the choice of a wheelchair. Conflicting aspects can be discussed. On the other hand, the designers can try to avoid producing conflicting design by taking better notice of conflicting aspects. For instance, a smaller table or a table that can be folded aside does not limit the mobility of a PwD. In general, the accessories can be designed in such a way that they can be removed independently of other accessories and preferably by the PwD.

More efficient use of employees and time

A weak point of FWW is the irregular productivity, which results in long waiting period between the order of a wheelchair and the actual delivery. With a better organization of the production this can be improved. FWW can try to standardize the parts and sub-assemblies, so these can be produced in higher quantities at the time. By specializing employees in certain activities, they can make parts and sub assemblies much faster and in advance of the orders. This is only possible if the products are documented in proper drawings and instructions. The production of parts in advance should only be done with parts that have been proved to be durable.

Policy on volunteers

PwDs and caregivers in Chiang Mai can be involved in the activities of FWW in a creative way. Simple tasks like cleaning and sandpapering can be done by any client in exchange for free service. This way local PwDs and caregivers are more involved in the activities of the workshop and the employees of the workshop can concentrate on more specialist activities like welding, bending and

production of special seating. On the other hand this is a good opportunity for the employees of FWW to have more contact with local wheelchair users and use their knowledge and experience to improve their products. Another advantage is that the workshop becomes less dependent on foreign volunteers.

Improvement of product range

With the current models of FWW the most problems encountered can be solved. In the case of Atipong and Tanyarak a wheelchair is not the best solution, since both persons can do without a wheelchair in the house and are not able to propel a wheelchair away from her house (see Appendix XVII.I). The best solution is more therapy. In case of Waruni, this will not be beneficial. The provision of a device for long distance mobility can be of greater help. The product range of FWW can be completed with a design of a tricycle or tricycle unit that can be added to the 3-wheel wheelchair. This will increase the outdoor mobility of many PwDs. FWW is capable of building such equipment, since they have built a hand bike before in cooperation with SES. Partner organizations of Motivation and initiatives of the Wheelchair Workshop in Vientiane have already led to designs and production of such devices (see Appendix II) and Exchange of information on wheelchair design can work beneficial for both organizations.

Product improvements

The adjustability of the footrests can be improved. If footrests are too low, the feet will point to the ground. This position can cause a shortening of the Achilles heel. If a PwD has the ability to learn to walk, first the Achilles heel must be lengthened again. Therefore physiotherapy is needed, while that can be prevented. If footrests are too high, the pressure on the seat will concentrate on the buttocks, and not on the entire upper leg. This can cause unnecessary skin irritation, pressure sores and spasm. In 2001 Motivation already suggested improvements of the adjustability of the footrest. Drawings of these suggestions are available at FWW, but have never been implemented. Implementations of these changes will improve the model substantially. Another observation is that most PwDs do not wear shoes, slippers or socks. Therefore the footrests must be sufficient to support the whole foot. If a footplate is too small, this can cause a curled position of the foot or feet to slide of the footrests.

Some ATDs are too big to use inside, while the seating system itself will benefit the PwD inside as well. For the CP-buggy it can be considered if it is possible to add a system to be able to disconnect the seat from the carriage so the seat can be used inside as well.

FWW also started with the production of PVC wheelchairs. They can be produced much faster and fewer skills are needed for production. The current models of PVC wheelchairs do not meet the needs to gain independent mobility and do not meet ergonomic needs, but the chairs are appropriate for short time needs so the metal workshop gains more time for the production of wheelchairs for the long-term use. It is recommended to keep experimenting with PVC and pay specific attention to seating ergonomics and safety and the improvement of durability.

6.2 Recommendations cluster 2

Improvement of capacity and actor activities

The limited time and capacity during the process of wheelchair provision can be solved by using all the available knowledge. Since the best expert on wheelchair use is an experienced wheelchair user CMDC, McKean and FDC can ask their most experienced clients to assist in the process of wheelchair provision. FDC already organizes wheelchair basketball training at the grounds of NCDC for the members of DCC. Members of DCC are already involved in the improvement of social participation of PwDs and can be a great help in the evaluation of wheelchairs after the donation. FDC and NCDC have already taken the initiative for better cooperation and division of activities within the assistive technology services considering CBR and DCC is already involved in the improvement of social services.

By involving a diversity of medical, social and technical facilitators and representatives of PwDs and dividing the responsibility of the wheelchair provision, the different actors are forced to cooperate and will automatically learn more from each other and PwDs can be involved much earlier in the ideation matching and selection of appropriate technology.

Improvement of technological possibilities and technical service

The Wheelchair Foundation can improve the state of their models by making local technical facilitators responsible for technology related aspects. Problems caused by technical problems can be solved by involving local technical facilitators in technical maintenance. It would give PwDs a location to require spare parts. Another option is to pay more attention during the selection of models to the availability of parts that wear out or make use of the availability of local technical skills. Since the number of wheelchair workshops is limited, this can be done by integration of wheelchair services in bicycle maintenance and repair shops or hardware stores. Many of these shops already function as suppliers of basic material and bicycle parts as well. Therefore INGOs can consider making contact with local businesses, to expand their activities for wheelchair service. Another option would be to order local manufacturers to produce wheelchairs and use the existing dealer networks for maintenance and service.

Since Wheels of Hope encounters similar problems, similar recommendations can be given. Disadvantage of the wheelchairs of Wheels of Hope is that they are already second hand models and differ very much, so it is difficult to donate spare parts. An advantage of the models of Wheels of Hope is that the diversity of models is much larger and therefore also clients with special needs can be helped more often. Wheels of Hope realizes the need for individual adjustments, local service and maintenance. They already have a local representative for follow up and contact with cooperating actors, to improve the product delivery to the needs of the PwDs. Wheels of Hope is looking for possibilities to start wheelchair refurbishing in Thailand, to be able to improve their products to the individual needs of the PwD. The technical facility at McKean can be used to refurbish, adapt and adjust wheelchairs locally. This makes the organization much more flexible and less dependent on donated models from the US.

6.3 Recommendations cluster 3

Improvement of PwD assessment

Hospitals should be more aware of the consequences of the provision of inappropriate ATDs and could inform their clients on the different wheelchairs available and the needs of the individual and assist PwDs and wheelchair dealers with the assessment. Since most hospitals are not specialized in rehabilitation, they can refer clients to other specialized rehabilitation centers or PwD interest organization for advice on what kind of wheelchair will be appropriate in the given circumstances and where ATD can be obtained.

Improvement of relations between PwD, dealer and manufacturer

The sales persons of the pharmacy stores are not always trained to prescribe a wheelchair. Better instructions by the manufacturer and above all, more contact with PwDs can improve the knowledge about wheelchair provision. Since none of the wheelchair manufacturers produces a wheelchair appropriate for use in rural circumstances, this seems to be a new market for the traditional wheelchair manufacturers.. Considering the fact that most manufacturers do not have immediate contact with the clients, this would be an opportunity to improve their products by using the knowledge of PwDs to improve their products and reduce the distance between the PwD and the manufacturer. A better relation between the client, dealer and manufacturer makes it easier to obtain information and gather information about likes and dislikes of the products. Clients can be asked to return to the dealer for inspection or asked to fill in a questionnaire, in which the way of use and opinion of the client about the product is examined. Clients can be stimulated to do this in return for free service or as part of the conditions to be able to claim a longer period of guarantee. On the short term, PwDs and dealers can benefit from these activities, because dealers will get feedback about the products they sell and PwDs have the opportunity to express the way in which the wheelchair meets their needs and can request for better examination, adjustment or adaptation and the availability of accessories. In the long run, the manufacturers will get a better idea about the needs of their clients and this can give them a better position in the growing competitive market. Manufacturers can also assume a more active role, but this requires a more active attitude in design and product improvement. Tools from design methods, where the actual user is involved in the design like USERfit, (Poulson, 1996) can help large manufacturers to improve their wheelchair models. If wheelchair users from rural areas will participate in future design and product evaluation, this will lead to the design of more appropriate wheelchairs for the rural circumstances. Another possibility is to seek cooperation with organizations that already have experience in the design and production of wheelchairs in developing countries.

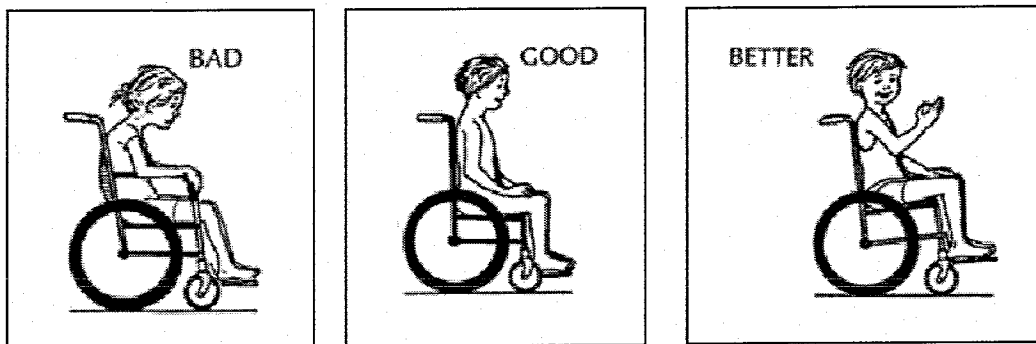


Figure 30. Small changes in measurements can sometimes have great results in ergonomic position. Experienced wheelchair users know what is comfortable and what is not. Even if PwDs have great difficulties with communication, the opinion of the PwD can be obtained by looking at the expression on a face or a conversation with the primary caregivers (Werner, 1996; Ch. 64).

6.4 Overall recommendations for clusters and actors

In most cases where the provision of assistive technology fails insufficient attention is given to the needs of PwD and caregivers. By involving the PwD and caregivers during the entire procedure of ATD provision, many problems can be prevented or solved. Experienced PwDs can help in the provision process and enlarge the capacity, knowledge and skills. Therefore it is recommended to organize regular meetings to discuss the problems and opportunities that can lead to an improvement of wheelchair provision for people with a disability in Northern Thailand. All organizations can take the initiative to organize these meetings. The most important aspects to achieve the improvement of appropriate wheelchairs are discussed here. More attention to ergonomic aspects for better fitting and manoeuvrability can be given if more time, capacity and knowledge are taken to assess the measurements of the individual PwD.

Improvement of suitability

A wheelchair should have measurements that fit the body measurements of the PwD. Since most experienced PwDs have basic knowledge about wheelchair fitting, they can assist during the assessment and evaluation and teach other PwDs on how to use their wheelchair. In this way wheelchair users can do something in return for the provided services and improve the basic manoeuvrability, while rehabilitation institutes can give more attention to the final adaptations to prevent further problems by paying attention to the need for accurate body support. This support can be realized by seating systems and accessories. Since there are only a few organizations that can provide seating systems in Northern Thailand, this is an opportunity for new production initiatives. Besides the actual suitability of the wheelchair to the body, the wheelchair should be suitable to the activities and participation of the PwD in social life. This can be improved by giving more attention to options and accessories to meet the personal needs of the individual and caregivers.

Improvement of manoeuvrability

Since 80% of the PwD lives in a rural environment there is an opportunity to produce more wheelchairs suitable for use in rural conditions. Cooperation between organizations that have experience with such wheelchairs, like FWW, Motivation and WWI and local manufacturers that have the ability to produce wheelchairs in larger quantities can result in an improvement of the availability of wheelchairs usable in rough conditions. This is in line with policies of several INGOs, so it is not expected that there will be great difficulties in realizing cooperation. Since several manufacturers already produce wheelchairs of alum alloy the combination of this material and the model of the 3 wheel wheelchair of Motivation could result in a great improvement of this wheelchair considering the manoeuvrability and related independence of PwDs. For the manufacturers this could result in an expansion of activities and a better market position, since there are no large manufacturers in Asia that produce suitable wheelchairs for rural conditions.

Improvement of maintainability

The maintainability of wheelchairs can be improved by improving the awareness and ability to maintain a wheelchair or by reducing the need for maintenance. This is a personal preference. Choices like solid tubes or air tubes can be an optional choice or manufacturers can involve a representative group of PwDs during the design of new wheelchairs. Wheelchair providers can check if the PwD and caregiver are able to maintain their devices and, if not, undertake action. Responsibility for maintenance can be given to the PwD and caregiver, if they receive proper instructions and proper tools and spare parts are available. It is recommendable to keep in contact with PwDs because there is always a need for medical monitoring. Coordination and cooperation between medical services and technical services can make the ATS more efficient.

6.5 Reflection on ATS

The conclusion and recommendations mentioned before can be reflected on the sub-definitions of ATS. This is done to be able to see to what extent this research provides aspects for improvement and to what extent further research is necessary. Since this research focuses on the aspects of needs evaluation and technical services, most recommendations mentioned before have a direct link with these two aspects. A full description of these aspects would result in a repetition of recommendations of paragraph 6.4.

Financial services

Since little attention is given to the way in which the actors organized the actual financial aspects, this research can not give much information about the actual financial needs of the different actors. The financial problem seems related with the limited time and capacity of the organizations. This can be further examined with an economic study or ex post policy evaluation to investigate if the financial policy of the organizations were realistic and check if the policies have been implemented and resulted in positive executing of services in practice.

Coordination

More cooperation is needed between the different actors and the different clusters and the PwDs and caregivers. The current problems concerning the limited coordination can be discussed by the organization of regular meetings of the actors. It is not possible to give advice on the improvement of the execution of a better coordination, because therefore the management skills and capacity of the organizations and the willingness to cooperate with other organizations have to be examined.

Personal training

Personal training can be improved by using the knowledge and skills of the local experienced PwDs and caregivers. These activities can be organized by existing PwD organizations like DCC or by clients on request of existing service providers. A more elaborate statistical study can give more information on the actual need for personal training.

Professional training

Although most knowledge and skills to realize ATS are available in Northern Thailand it is not possible to the organizations have the time and capacity to organize professional training. A more elaborate study on the actual need for professional training and the current activities on the field of medical rehabilitation, CBR and technological activities can give more insight in these matters.

6.6 Recommendations for future research

This research has the aim to improve the provision of assistive technology services for PwDs in Northern Thailand and does that by focusing on the constraints during activities of ATS by focusing on activities PwD needs and technological services of the local facilitators. During this research a new model of assistive technology provision is used. During the research many other interesting aspects are found that are not embedded in the current research model and could not be examined in detail. Here the most important aspects for future research are discussed. The previous paragraph already shows that there is a need for improvement of the other aspects of ATS that are not included in the model. This paragraph takes a closer look at the current research model and the difficulties during the research. Suggestions for more detailed research are given to obtain more information on the aspects of PwD needs, technological possibilities and business opportunities.

Evaluation of the research model and research instrument

During the creation of the model an attempt is made to make the model applicable independent of the actual situation and actor. Since not all activities in the model are executed in the empirical situation of Northern Thailand, the model does not fully represent the assistive technology provision in that area. The model can be adapted to the actual situation in Northern Thailand, but since all clusters have their own specific way of working, this will result in a diversity of models. The model does shows that many activities are necessary to come to an appropriate wheelchair provision. The used indicators only contain a limited number of aspects. While assessing an individual PwD, some indicators do not provide sufficient detail information and the used indicators and more aspects are found that could be taken into consideration during the ATD provision. The model is not precise enough to judge every individual case. Since every individual has different needs and different actors have different working methods, it is only possible to take the most important aspects into consideration. The research instrument fails to indicate the tacit knowledge of the actors. Partially this is corrected by the investigation of the responsibility, but only the result of the whole process can prove if the assistive technology provision is executed correctly. In all research situations, the evaluation is not executed in the way in which the model suggested. This can also be said about the training, testing and monitoring of PwDs and their wheelchairs. To be able to prove that these activities have to take place to be able to improve the assistive technology, similar research has to be done in a country where evaluation and monitoring is done more frequently, like in the UK or in the US.

Sometimes the wheelchairs itself embeds a number of positive properties, which seems to make it irrelevant if certain activities are executed or not. The basic 3 wheel model of FWW is appropriate for use in rural conditions. As long as the employees make the models according to the concept, they do not have to know why this model is appropriate. Similar things can happen, if a good assessment method and measuring system is used. As long as the procedures are followed, the result will be satisfactory. In practice there is the risk that employees leave out or change certain aspects, which results in a failure of the whole provision of an ATD. The model and research instrument is of great value to collect the most important data on ATS as it should be executed in rehabilitation practice, but the researcher must have sufficient knowledge and background information to be able to identify other relevant aspects in rehabilitation practice.

Reliability of the collected data

Since the data is collected at a large diversity of actors with several data collection methods, the researcher has quite some influence in the decisions in which data collection methods are used and how the data is combined. Since the researcher is also a western volunteer, his perception can be biased by cultural aspects. Interviews with staff members and employees of organizations and staff members are interviewed in English. All interviewed people can speak basic English. Several staff members or employees of a single company are interviewed to be able to clear out misunderstanding of questions and the risk of biased information provided by company representatives. The clients of the organizations are interviewed as well, to be able to check and correct the collected data from the service providers with the experienced practice of clients. For cluster 2 and 3 the collected data is limited. Cluster 1 is examined in more detail. Information of existing files are combined with the information collected during home visits.

Cultural and language difficulties occur during home visits. Although the employees of CMDC speak basic English, they do not always translate the questions correct or do not feel comfortable. On the other hand, some PwD and caregivers do not feel comfortable answering questions, since in Thai culture it is considered impolite to complain about services that are provided for free. Even if you pay for services, it is a responsibility of the buying party to investigate and bargain for a good deal. If people are not satisfied with the goods they bought, they blame themselves for not bargaining sufficient and not the salesperson for not providing sufficient information or low quality goods. If people do not use the ATD or if an ATD does not fit or is not appropriate and therefore difficult to ask questions about that straight forward. These issues were discussed with Kasinee Wuddhiwong, researcher at the department of public health nursing of Payap University. In the given circumstances it is not possible to use a method that can prevent all cultural and language problems and avoid embarrassment or loss of face of the PwD or host organizations. If interviews are held at the PwDs and caregivers, without any introduction by the host organization, people would be suspicious and they are not likely to cooperate. A few changes are made in the order of the questions, so delicate questions would be asked at the end of the interview. Since it is possible to visit some of the PwDs several times, the first visits are primary used for observation and interaction with the PwDs and caregivers, to create a situation of trust and comfort. This way the next visits there will be less restriction for the PwD and caregivers to answer more delicate questions or cause uncomfortable feeling during interviewing. In some occasions the information is given without asking any questions, since several Thai people feel it as a relief to be able to tell their story. This is surprising because in the Thai culture conversations about inner feelings are rare. If time and resources allow it, in a similar way, contacts are made with people from other organizations and the collection of data is spread over a number of visits.

Internal validity of the results

The test of representativeness in Appendix XII shows that the investigated actors do represent the majority of the facilitators, but that the number of investigated PwDs and caregivers is relatively small. For cluster 1 sufficient data is collected and analysed, to be able to come to conclusions. In cluster 2 and 3 most data is obtained from involved persons of the organizations and only a few PwDs and caregivers are interviewed to be able to verify the provided information.

External validity of the results

The external validity of the results of this research is limited. This results can only be considered valid outside Northern Thailand if it is proven that the circumstances in other areas are comparable with the circumstances as they were during the time of research in Northern Thailand. Since the snowball

method shows that the actor networks and clusters can be so different, even in the same area that is hard to prove. The conclusions and recommendations can be of great value in situations where similar actors cooperate. The conclusions and recommendations of cluster 1 can be useful in other situations, where local workshops produce wheelchairs with the help of technology transfer from donor organizations. The conclusions and recommendations of cluster 2 can be useful in other countries where Wheels of Hope, Wheelchair Foundation or similar organizations donate products in a similar way. The conclusions and recommendations of cluster 3 can be useful in many other developing countries, where local manufacturer produce standard hospital wheelchairs without realizing the importance of individual attention to the PwD, caregivers and their environment.

Suggestions for related future research

Besides the suggestion for further research on other aspects of ATS as suggested in paragraph 6.5, suggestions are given for related research on more detailed issues. Due to the complexity of the rehabilitation assessment and different clusters of assistive technology services it is not possible to do detailed research on the user needs. Future research on rehabilitation subjects can be more specific on subjects of ergonomics like special seating needs, special target groups like CP children or more general needs like short-distance and long-distance mobility needs. More technical related research can be done on subjects like the improvement of local design skills, production skills or the implementation of large scale production of ATD for use in rural circumstances. In different technological fields, small enterprises are specialized in bicycle parts that are made with similar technology with which wheelchair parts can be made. PwDs and manufacturers will be interested in this research, since both subjects offer new opportunities on the Thai market. In and around Chiang Mai, many companies are specialized in making and refurbishing motorcycle seating and furniture. Sewing services can be found in almost every street, so the potential to produce special seating for wheelchairs is available. More detailed research to the opinion of PwDs about their wheelchair is the key to success to future wheelchair design. A more detailed research can be done under a larger group of PwDs and caregivers. With a similar study more information can be obtained about the opinion of PwDs about the initiatives of use of alternative materials like PVC and other local material like bamboo to build wheelchairs for a low price with local skills.

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APPENDICES

I. AN INTRODUCTION TO THAILAND AND THE DISABLED PEOPLE

History of Thailand

A unified Thai kingdom was established in the mid-14th century. A bloodless revolution in 1932 led to a constitutional monarchy Thailand is the only Southeast Asian country never to have been taken over by a European power and the Thai are very proud of that.

Culture and religion

Buddhism is the state religion and its values are fundamental in Thai society and life. Although most Thais are Buddhist, there is a religious freedom in the country. Today Thailand has almost 65 million inhabitants. The majority of the population is Buddhist (95%), 3.8% is Muslim, Christianity 0.5%, Hinduism 0.1%. Thai is the national and official language and it has its own distinctive written form and dialects.

Geographical information

Thailand covers an area of 511,770 sq km geographically, the country comprises four regions: the mountainous in the North, the central plain, a semi-arid plateau in the Northeast and the peninsula in the South. The capital is Bangkok and one in 10 Thais lives in the city. Bangkok is the largest city in the country, about 45 times larger than Chiang Mai, the second most populous city. 70 % of the total population live in the rural areas while the rest live in cities or urban areas.

Economy and income

Since the 1960s, the country has undergone seven national economic and social development plans. Thailand also diversified its economy and boosted its agricultural exports, industries and manufacturing. From the late 1980s to the early 1990s, the manufacturing and trade portion of its gross domestic product almost tripled that of agriculture. Thailand has recovered from the 1997-98 Asian Financial Crisis and was one of East Asia's best performers in 2002. Increased consumption and investment spending and strong export growth pushed GDP growth up to 6.3% in 2003 despite a sluggish global economy. The division of the labour force was in 2000 estimated at agriculture 49%, industry 14% and services 37%. Most industries are concentrated around Bangkok, due to the good exports feature textiles and footwear, fishery products, rice, rubber, jewellery, automobiles, computers and electrical appliances. This booming area has caused the prices in Bangkok to be about 200% of the prices in Chiang Mai.

Many Thais have seen vast changes in their quality of lives and many are enjoying more material comforts. However, rural poverty is still the most pressing problem. The lives of the impoverished, including disabled persons, show only little signs of improvement. 10.4% (2002 est.) is still living under the poverty line. In the lowest 10% of the income group has only: 2.8% of income to share, while the highest 10% of the income group has contributed for 32.4% to the consumption (1998). The high incomes have caused that the average income exceeds the UN standards of a developing country. Thailand is now considered a New Industrialized Country (NIC).

Disability Statistics

No national census on disabilities has been conducted in Thailand. However, three disabilities-related surveys have been conducted in Thailand. In 1991, the Ministry of Public Health the National Statistical Office (NCO), and the Office of the Prime Minister first conducted a disabilities survey in the country that gave two classifications, medical and educational. The medical survey classified disability for treatment and rehabilitation purposes, while the educational survey perceived disability as physical and psychological abnormalities that may be a burden or problem for society. The National Statistical office is regularly conducting a nationwide survey of the disabled population every five years, which is a part of the Health and Welfare Survey. The latest survey conducted in 2001 discovered a majority of

persons with disabilities. Nearly 80% are living in non-municipal area. The Ministry of Public Health conducted National Health Examination Survey in 1991 and 1996, which contained questions treated to disabilities. However, these surveys are only used internally. In 1999 Japan International Cooperation Agency (JICA), a government development agency of Japan, in cooperation with the Council of Disabled People of Thailand (DPI-Thailand) conducted a limited survey for persons with disabilities in Thailand. The office of Empowerment for Persons with Disabilities under the Ministry of Social Development and Human Security has registration service for persons with disabilities. In which, 343,526 persons with disabilities registered as of 31 January 2003.

Politics and Legislation

Traditionally, persons with a disability were looked upon as people who could not take care of themselves. This resulted in reactions of neglect, overprotection or the alteration of discarded. Slowly the attitude towards disabled is changing. Since the 1980's the overall acceptance and awareness of disabled persons has grown in Thailand. In the National and Economic and Social development plans, the disabled were seen as a special target group. Extra attention from the UN and ESCAP on disabled persons the last 2 decades resulted in equal right for disabled persons. The implementation of the World Program of Action concerning Disabled persons of the UN Division of social policy and development has led to the bill of Rehabilitation. Since 1994 this Act guarantees the rights of PwDs on medical access, educational opportunities, vocational training and social rehabilitation.

Education, Training and employment for PwDs

According to the Act, people with disabilities are entitled to receive an education from pre-school to university levels. Policies before the act resulted in a divided school system of special schools for disabled persons (most are boarding schools) with a similar school program as the general mainstream schools. In those schools PwDs have the right to participate at all levels, up to tertiary level. They can study in their own tempo. There are also classes in hospital for children with disabilities. Current government policy is slowly changing in promoting more education in the regular educational system. In 1999 about 3,500 disabled children were studying in more than 200 mainstream schools around the country. There are now 16 government and private vocational training centres for PwDs. Since 1994 all vocational training institutions must accept students with disabilities. In practice the limited knowledge of the teachers about disabled children and adults and their special needs makes it sometimes difficult to accept disabled persons in a regular school. In other cases schools are not accessible for PwD due to architectural and infrastructural obstacles.

All government organizations and public enterprises must employ people with disabilities. Employers or private entrepreneurs with more than 200 employees must employ one person with disability. For those who prefer to start their own businesses, they can apply for a five-year no interest pay-back loan from the Rehabilitation Fund for Disabled Persons.

The Government of Thailand is well aware of the difficulties faced by people with disabilities when travelling to schools, workplaces or for social activities. It has already established a committee to draft regulations on accessibility. Committee members include experts in design and construction and people with disabilities. Their work is almost complete and details of the regulations will be announced soon. In addition, the Committee for the Rehabilitation of Disabled Persons and self-help organizations of disabled persons are advocating together to ensure the access of disabled persons to the public transportation systems to be built in Thailand.

Medical care and rehabilitation strategies

The health care system

From a historical point of view, missionaries initiated healthcare. Nowadays many organizations of different origin contribute to the assistive technology service. The governmental social and medical support system is improving and still a lot of help of numerous initiatives of national and international

NGOs try to address something the current social position of the disabled. Technical facilitators provide assistive technology devices and services.

In Thailand, the medical standard in big cities is comparable to western standards. Private institutions have the best care, but private healthcare is too expensive for the majority of the population. In the provinces and rural areas the health care standard is much lower.

Most of the public or state owned hospitals fall under the responsibility of the ministry of public health. There are general and regional hospitals which serve the province or have a national status. The health centers at local level serve one sub-district or a number of villages. Community hospitals are available per district. In almost every province there is a general hospital. The university hospitals and private hospitals fall under the responsibility of the ministry of University Affairs.

Institutions with competent staff are important for the provision of special assessment and surgical intervention, treatment and specialized equipment (WHO, 1994). Unfortunately, public hospitals have a limited budget and capacity. For PwDs medical rehabilitation units are set up in 99 hospitals for the provision of Institution based rehabilitation services (IBRS). In those units PwDs should receive special treatment or short-term intensive therapy. The number of rehabilitation personnel is far behind the disabled population. Since 1982, training courses in the field of rehabilitation are held to increase the number of qualified staff. The institutions approach focuses on the person's disability and gives little attention to the family, community or relevant social factors (WHO, 1994).

Community Based

An innovative approach of healthcare in the villa is to establish self-help programs. The objectives of the programs are to expand the coverage of health services by using community resources at the village level by training a Village Health Communicator and a Village Health Volunteer responsible for health education, information and curative aspects. The VHC can refer the rural population to the provincial hospitals. Comparable activities of INGOs and NGOs were performed in the field of rehabilitation. Community Based Rehabilitation (CBR) is characterized by the active role of the community and family in the rehabilitation process. Knowledge and skills for basic training are transferred to the involved community. A committee promotes the removal of physical and attitude barriers and ensures opportunities for the PwD within their own community. Disabled children attend the local school. Community resources are supported by referral services within health, education and labour and the social service system. Personnel skilled in rehabilitation technology train and support community workers and provide skilled intervention if necessary (WHO 1994).

INGOs and NGOs

The gap between the public social and medical care and the need of the PwDs has been filled by about 50 Thai NGOs and numerous international welfare organizations. Many organizations prefer to work on their own or for a selected group of disabled people. Some organizations try to focus on a selected location or impairment, while others try to help whoever needs help. A number of NGOs were founded by foreigners, who started special education in Thailand and established institutions. Other NGOs were started by PwDs themselves. Some of these institutions consider the assistive technology service as a part of their responsibility. Second hand wheelchairs and numerous of new wheelchairs are donated by NGOs. A lot of times these organizations do not realize that wheelchairs are not made for the circumstances in Thailand. This results in early break-down, unrepairable products or badly fitting equipment.

Wheelchairs in Thailand

The wheelchairs available for PwDs is a mix of traditional hospital wheelchairs, new and second hand donated wheelchairs from INGOs and NGOs and wheelchairs built in small or medium enterprises. Several manufacturers and workshops produce wheelchairs in Thailand. Most wheelchair manufacturers are located near Bangkok and produce wheelchairs mainly as part of a hospital collection. In recent years, several local initiatives were taken to combine the creating of employment with the production of assistive technology for PwDs.

Usability of wheelchairs in Thailand

Unfortunately many of their models are only usable in indoor situations, or in good developed infrastructure. They can only be used in the urban areas. Thailand has still many characteristics of a developing country. In the rural areas the usability of these wheelchairs is very limited. Often

wheelchairs are badly adjusted, do not fit properly or brake down very soon in rural circumstances. Only a small number of organizations makes wheelchair suitable for rural conditions. In many cases organizations and institutions fail to match the wheelchairs with the individual user, because they do not realize that the individual needs of every single PwD is different and changes over time.

Recent trends in Thailand

Most governmental institutions INGOs and NGOs are well aware of the shortcomings of their own services. Recent trends in rehabilitation are the cooperation between governmental organizations and NGOs working together with the disabled.

Actors in ATS

Despite the efforts of the government in the last decade, the special care for PwD is not sufficient for the number of disabled people in Thailand. A number of INGOs and NGOs are providing services especially for PwDs. Cooperation between the different organizations is still limited. The wheelchairs available for PwDs is a mix of traditional hospital wheelchairs, new and second hand donated wheelchairs from INGOs and NGOs and wheelchairs built in small or medium enterprises. The following actors play a role in the assistive technology service:

PwDs

As individuals, but also organized in different NGOs, PwDs have organized themselves on different levels, for political pressure on advocacy campaigns, or self help services. More and more, PwDs come up for their rights and try to change the traditional cultural view. They organize themselves to realize equal rights, better healthcare, education, job creation and own initiatives of building and improving assistive technology devices.

Caregivers

The role of the primary caregivers is not obvious. It is likely that they are involved in CBR.

Social facilitators

INGOs and NGOs involved CBR try to improve the social circumstances. They consider the assistive technology service as a part of the total social welfare service.

Medical facilitators

The government is responsible for the 99 units special units for rehabilitation. Dependent on where the PwDs live, they can visit a hospital by themselves, or come into contact after consulting a Village health communicator (VHC). Some hospitals are involved in the assessment for seating and wheeled mobility systems. Some INGOs and NGOs have their own medical specialists. Some medical facilitators are involved in the provision of wheelchairs, but often they do not always have the technical skills for necessary adaptations.

Technical facilitators

A variety of large wheelchair manufacturers and medium or small scale workshops produce wheelchairs. A lot of wheelchairs are produced for the hospital market. Some hospitals have their own technical staff for service and repair while other hospitals go to the wheelchair dealers for service. Their role within the provision of wheelchairs for PwDs and the improvement of their products is not clear. Since many INGOs and NGOs supply wheelchairs as well, they can also be considered as technical facilitators.

II APPROPRIATE ASSISTIVE TECHNOLOGY:- APPROPRIATE WHEELCHAIRS?

Many wheelchairs have been given the title appropriate. Here we take a closer look to a number of wheelchairs, and ask ourselves, if they really are so appropriate.

The wheelchair of figure A is appropriate, in the sense that the frame is made out of locally available material, and it can be produced with local skills. The wheels and caster forks are the parts that run down. They seem to be genuine wheelchair parts, possibly not available on the local market. But it looks like the designer forgot who the user was. The model looks like an indoor hospital chair, but it has no push bar or handles. It looks like a wheelchair for an active PwD, with good control over his upper body, since there is no protection against the wheels. The wheel seems to be too far to the back, which makes it heavy to propel. The seat is horizontal, while a slight angle is preferred to prevent sliding. The footrests do not give any comfort at all. The wheelchairs above are a good attempt, to lower the price of the product and making the wheelchair lighter.



Figure A . Wheelchair prototype by J. O'Brien, designed in 1997, Seattle university.



Figure B. PVC wheelchair. Designed by D. Hammons in Khorat, Thailand.

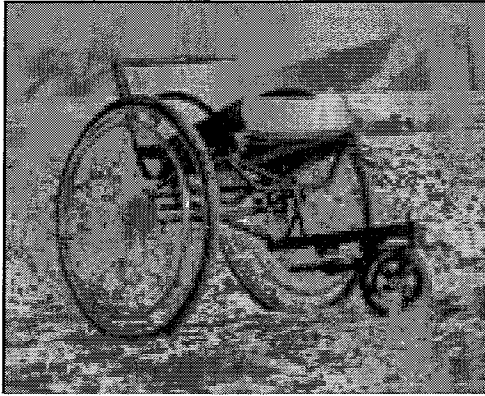
This PVC wheelchair of figure B is completely built with locally available material and skills. The price of the wheelchair is very low. The use of PVC is questionable, since the durability of the material is limited and uncontrolled burning can cause harmful gasses. Here again, the chair is too wide to give sufficient side support. The angle of the seat and backrest are uncomfortable and the distance between the seat and footrests is too small. This makes the wheelchair only suitable to give a short time solution for elderly or ill persons, with limited strength.

This PVC chair is also available in a children's model. Positive is the bright colours that attract other children. It is an invitation to play with the disabled children, and can even be used as a toy. Originally the paint was used to prevent degradation of PVC by ultra-violet light.

The wheelchair of figure C is appropriate in almost every aspect. Local craftsmen, who are trained to adapt the wheelchair to the measurements of the user, can produce it. It meets the ergonomic needs of the majority of the wheelchair users and the wide caster wheels make it easy to manoeuvre on sandy roads in a rural environment. The footrests are adjustable and the need for special seating is reduced. The wheelchair is foldable and therefore suitable for travelling. Nearly all the technical parts and material is locally available at reasonable price.



Figure C. ATI-Hotchkiss wheelchair for production in Afghanistan 2003.



Another proven design is the 3- wheeled chair of Motivation (figure D). This model can also be produced with the basic skills of a traditional metal worker, with a limited number of tools and equipment. It is appropriate for use in rural environment. The single caster wheel is visible for the user and due to the long wheelbase the chair can be used on mountainous terrain. It is easy to manoeuvre around holes, without the risk of losing balance. The measurement of the chair can be adapted to the needs of the user. The footrests are adjustable

Figure D. 3 Wheeled wheelchair made to meet the rural needs of PwDs in Afghanistan by assistive technology transfer by Motivation in 2003.

In some cases, the cultural aspects can affect the needs and request for another concept. In Asia, social activities like eating and cooking often occur on floor level (Figure E). In other cases, the lifestyle of job of the PwD request for a solution for long distance transport (Figure F).

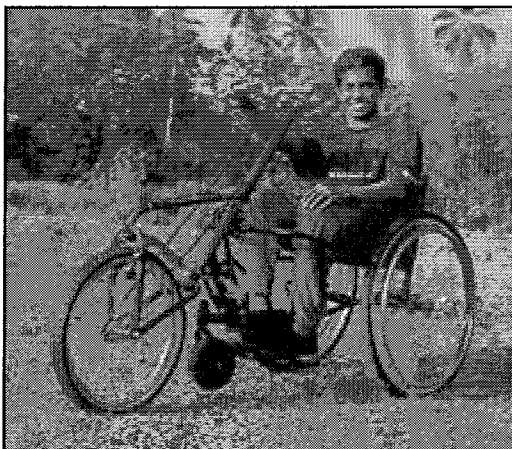


Figure F. A tricycle unit that fits on a 3-wheel wheelchair. Designed and produced by Motivation



Figure E. In many Asian countries a low floor model trolley is more useful than a normal wheelchair

Conclusion

Before we can conclude if a product is appropriate, we have to determine for what it should be appropriate. In the examples above appropriateness concerns the personal factors of the user, the activities of the user in his local surrounding. In other cases it is related to the possibility to produce and repair it locally, without damaging the natural environment or ending up with high costs. In the next appendix we discuss the concept of appropriateness.

III APPROPRIATE ASSISTIVE TECHNOLOGY- A DISCUSSION

In the previous appendix it was made clear that there are many aspects of appropriateness. Appropriate technology can be defined as: technologies and processes that are appropriate to the resources and needs of low-income communities. What appropriate is for one situation, does not have to be appropriate for the other situation. In the context of developing countries, it often means:

- simple to apply;
- not capital intensive;
- not energy intensive (requiring little non-renewable energy to do, build, or maintain);
- use local resources and labour; and
- nurture the environment and human health. (http://www.ncat.org/about_history.html)

The utility of wheelchairs has been especially limited in rural areas. A study conducted in India, based on an analysis of 47 wheelchairs in use in 46 villages in different parts of the country, showed that many wheelchairs were used as push chairs, because the prescription was not correct or because the chairs were so designed that family members were inclined to push the chairs. Although wheelchairs could be useful outside the home, the smallness of houses made them practically useless indoors. Furthermore, rough terrain led to quick wear and tear and breakages, especially of the castor assembly, main wheel and brakes. The exposed metallic parts were corroded by moisture, dust, mud, and other substances common in those villages. Finally, stability and controllability were inadequate (Saha, 1990)

The first priority seems to be to nurture the environment and human health. This can not be realized if a wheelchair meets the needs of the individual. A Wheelchair should fit the person and the wheelchair should be manoeuvrable in the local environment. If a PwD only can sit in the wheelchair and can not move in and around the house or use public transport, the wheelchair can make him even more disabled. For assistive technology it is important that maintenance and repair can be done locally.

The use of local resources and labour is a benefit for the local market, but considering the high need for assistive technology in developing countries it is questionable if local communities are capable of solving the problem. The concept of community bases rehabilitation (CBR) accepts the fact that local communities often can not help themselves and try to change that by education and the promotion of self-help organizations. The capital intensity is an economic debate. Due to globalization and economies of scale imported wheelchairs can be cheaper than locally available wheelchairs. If they are donated for free, this can disturb the market for local manufacturers and local skills can disappear. On the other hand, if a reduction of cost results in a lower durability, limited adjustability and higher maintenance, in the end of the day, the cost will be much higher.

It is a discussion about priorities. Most of the time charity organizations want to donate wheelchairs, because they want to help a PwD. They want to see a short time the result. As long as they have an eye for the local culture and environment and manage to give attention to the service aspects, they can help many PwDs. Organizations like WWI and Motivation Thrust prefer to train local people to make their own assistive technology. Their efforts have been impressive, but considering the fact that the need for wheelchairs is so enormous, even they consider large scale manufacturing, instead of small and medium scale local workshops (see Appendix IV).

Conclusion

In this report appropriate assistive technology will be defined as technology:

- Suitable for the personal needs of the individual PwD
- Manoeuvrable in the local environment
- Maintainable and repairable by the local labour force.

IV APPROPRIATE ASSISTIVE TECHNOLOGY- A CHANGE IN DEVELOPING AID POLICIES

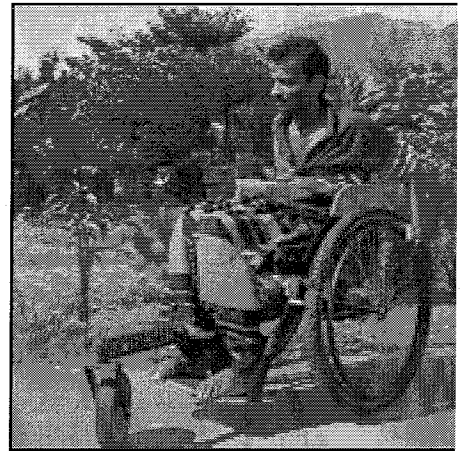
Recent trends in Wheelchair provision

The provision of wheelchairs can be divided into two categories. First the need of wheelchairs raise in disturbed areas by natural disasters, accidents or warfare. In other countries there is a structural need of wheelchairs, due to poverty of the population. In many situations they go together. In case of disturbance, countries are dependant on international help. This justifies the donation and supply of free aid, because the need is so high that local organizations can not meet the demand. In most cases, the first wheelchairs end up in hospitals for indoor use. In case of a structural need it is questionable if it is not better to solve the structural problem by technology transfer.

Globalization seems to influence the policies of INGOs and NGOs. Design method, production and distribution of wheelchairs is changing. Organizations who assist in the development of local skills also try to enlarge the production. The development of the medium and small-scale production is not sufficient to decrease the global need for wheelchairs.

"Worldmade will support a number of organizations in developing countries to establish local wheelchair services. These will include previous Motivation local partners and new ones. At the beginning of 2005 Worldmade will start producing and distributing 10,000 wheelchairs a year, progressively increasing production and adding new products to the range over the next few years. Worldmade uses the economies of mass production in order to reduce costs, but because the wheelchairs will be assembled by trained technicians, we will not compromise our core values of providing individually fitted, high quality, appropriate wheelchairs and pressure care cushions."

<http://www.motivation.org.uk/home/>



The Worldmade is a pre-manufactured product of Motivation and designed with a 3D-cad model to be mass-produced and assembled on the location of distribution. These changes in policies do not change the actual demand of appropriateness for the wheelchair users and their environment. They only change the design specifications of the manufacturers and distributors. Here there is a change of policy, where the ideal of creating employment is reduced to the actual assembly of the product.

In cooperation with three dynamic organizations, Whirlwind Wheelchair International has embarked on an ambitious, groundbreaking project to seed small wheelchair shops around the world. Called Whirlwind Industrialization Project (WIP), the goal is to "industrialize" local shops by teaching wheelchair-building using advanced jigs and fixtures to make precise, interchangeable parts as is common in developed countries where, on a grander scale, it is called mass production. The local shops will be more efficient and will build large numbers of high-quality wheelchairs faster, thus being competitive with domestic and imported wheelchairs in their local marketplaces."

http://www.disabilityworld.org/11-12_03/access/wwi.shtml

On the other hand do INGO organizations which focus on the donation of wheelchairs start to realize that they should take initiative in dividing the responsibility on the assessment of PwDs for wheelchairs, the training of PwDs on subjects like pressure sore prevention and wheelchair maintenance and the training of local people for service and repair.

(<http://www.disabilityworld.org/Aug-Sept2000/tech/Hamlet.htm>)

If we look at the situation in Thailand, there is still a structural need for better wheelchairs. Some local manufacturers, like THAIWheel have been able to grow from a small-scale workshop to a modern production facility. To keep the factory productive, they have to have sufficient orders. While they can not sell their products on the local market, and the budget of WAFCA is not sufficient to keep the production going, they try to produce wheelchairs for other countries in need.

Thailand Donates Wheelchairs to Afghanistan

One hundred locally made Thai wheelchairs were donated to victims of war in Afghanistan through the collaboration of public and private organizations in Japan, Thailand and Afghanistan. It was a project of the Wheelchairs and Friendship Center of Asia (WAFCA) and Minsai Center, Japan.

The donation was to provide assistance to persons with disabilities (PwDs) in Afghanistan, particularly children with disabilities since landmines have maimed many children during and after the war. The Thai wheelchair industry is pleased that international organizations have acknowledged the quality of Thai made wheelchairs. The factory can produce wheelchairs much cheaper than those manufactured in Europe and Japan approximately 1,000 wheelchairs per year with 14 staff 10 of whom are PwDs.

(APCD, 2003/ Bangkok Post, 2004)

Conclusion

The awareness of the complexity of wheelchair provision is improving. Large-scale production of wheelchairs can reduce the enormous need, and does not have to have negative effects for the local employment. If foreign producers and donor organizations divide the responsibility for assembly, and maintenance to local professionals, they can guarantee the technical functionality of their donation. Even more important is the responsibility for the personal fitting and manoeuvrability in the local environment. This can be achieved by training PwD and professionals in wheelchair assessment, wheelchair use and basic maintenance. If large-scale production in the donating country itself is possible, this can have an even bigger effect on the solution of the structural problems. In Thailand this seems possible.

V. REHABILITATION ASSESSMENT METHODS AND PRACTICE

This Appendix takes a closer look at the assessment methods of PwDs. In other theories this is called evaluation. In both situations the purpose of the assessment is to gather information to be able to subscribe an assistive technology device. This study concentrates on the provision of wheelchairs.

The assessment theory of Mayall shows the most important aspects of attention in a wheelchair-positioning situation (Mayall, 1995). This theory was made in England where disabled people are referred to specialized rehabilitation centers for special care and the social welfare system or insurance will cover the costs. (see figure A). Wheelchairs are chosen out of an existing supply of models approved by official legislation and insurance companies. These are provided. In some cases, only a limited range of products is available. Positioning is done by a small group of rehabilitation specialists in a hospital environment or at the clients' home. In daily practice the attention to the different aspects of product design is restricted by the limited time and money available. The product has to be regularly adapted to the user and the user has to be trained in the use of the product (Mayall, 1995). On the other hand a social worker or medical specialist who has the task to assess a user for a proper wheelchair often has a limited number of chairs or tools at his disposal. Often a wheelchair is chosen and adapted at a later stage (Rosalind Ham, 1998). Evaluation of rehabilitation practice in the U.S. showed that besides the limited number of children receiving services and devices and insufficient funding for services or devices, a lot of problems can be prevented if more attention is given to assistive technology training and public awareness for professionals and families. Other aspects that need to be improved are the systems to assure outreach to underrepresented populations and rural populations. There is a lack of timely acquisition and delivery of assistive technology devices and assistive technology services. There is a lack of coordination between organizations and no information among targeted individuals about the availability and potential benefit of technology for PwDs (Lesar, 1998).

Since the context in developing countries is different, the validity of the model can be questioned. The following aspects should be considered as well:

- The identification of disabled people and the provision of help can not be taken for granted. The way in which disabled get help should be investigated.
- In many countries, the number of organizations involved in the actual assessment is much larger. All these institutions can influence the actual assessment and positioning. Therefore these must be identified and their influence must be determined.
- Under the influence of the regulations of the European Union the situation in the UK has changed. Nowadays clients have more freedom of choice. In some cases, wheelchairs are designed for the individual. In the model of Mayall is no space left for influences from manufacturers.

Conclusion

In most industrialized countries with a well-developed social system special institutions provide wheelchairs for PwDs. In the UK a team of specialist containing a rehabilitation engineer, a physiotherapist and a social worker are involved in the assessment (Mayall, 1995). In America a social worker or medical specialist has the task to assess a user for a proper wheelchair (Ham, 1998) The choice of wheelchair models is limited, because of budget restrictions, or a limited selection of approved models. In other states a small team of specialist is involved in the assessment of seating and wheeled mobility (Bergen, 1998). The methods used to provide a wheelchair contain similar activities. The order of the activities seems to be related to the background of the assessor. The activities contain the assessment of the medical situation and the determination of the level of independence, the personal situation and wishes of the PwD and primary caregiver are assessed. Bergen gives much more attention to seating issues. A selection of wheelchairs, adaptive equipment and seating systems is made out of the existing collection of assistive technology devices and accessories. These systems are judged on advantages and disadvantages of the products, availability, costs, maintenance and the likes and dislikes of the PwD and caregivers. There are differences in the order of activities. After choosing a wheelchair, the device will be tested and evaluated. If the device does not meet the needs of the PwD, the assessment will be refined. The device will be adapted or another device will be provided.

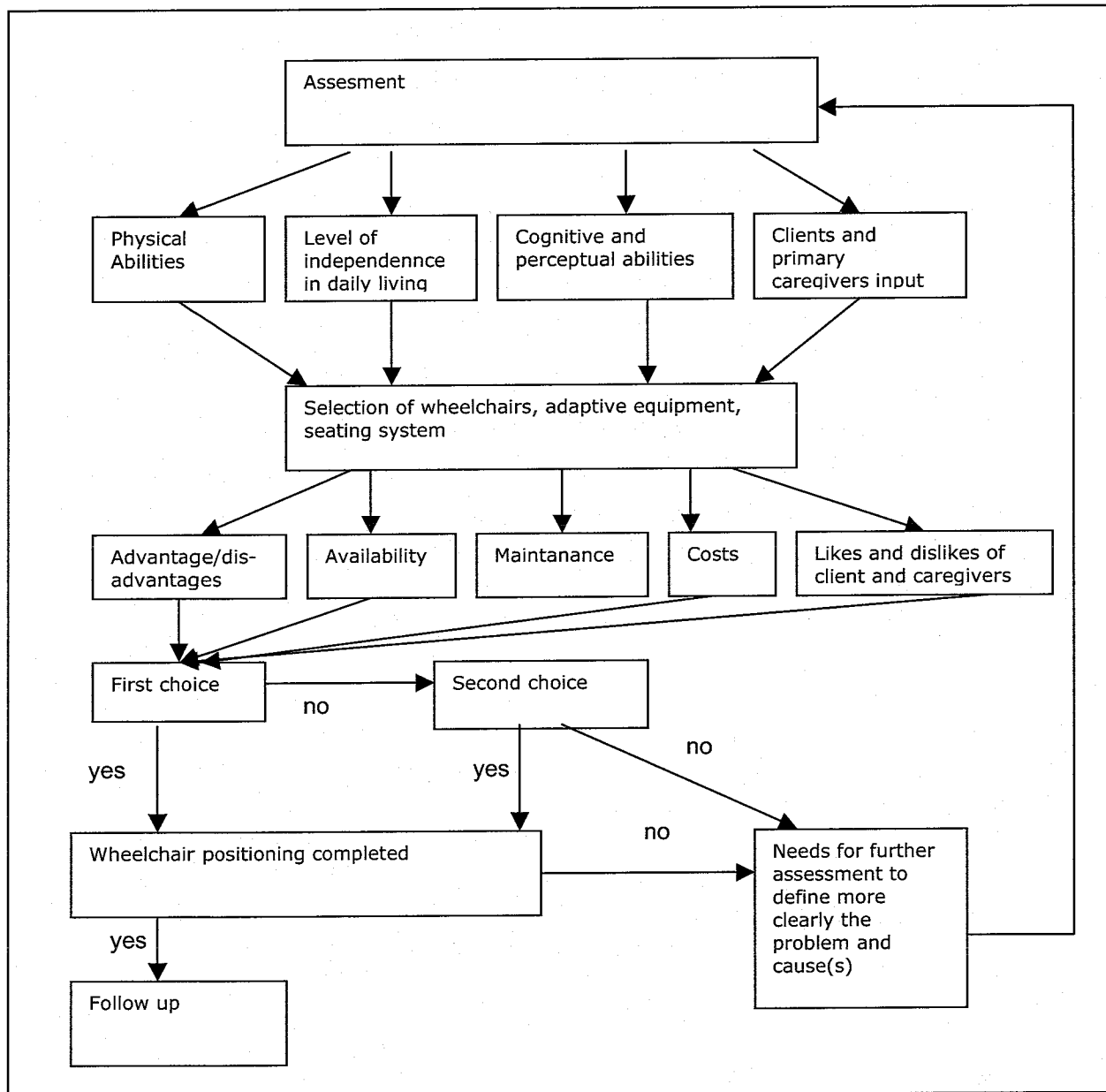


Figure G. Assessment model of rehabilitation according to Mayall.

The process of assessment of assistive technology devices like wheelchairs was described by Jan K. Mayall (Mayall, 1995). After assessing the PwD, he makes a first selection of possible wheelchairs and accessories. After a first selection, he evaluates, which models are affordable, maintainable and available. He judges the advantages/disadvantages and involves the clients and caregivers in the choice of one or 2 wheelchairs. If the product does not meet the needs, a more precise assessment of the client will be done. If the wheelchair is O.K., then follow up will be planned, for service and check-up of the assistive device and the PwD.

The methods used by these teams can be considered as the necessary activities or fields of attention, to establish a provision of wheelchairs for PwDs. Therefore they can be used in a general model of wheelchair provision. All models studied show a structure to identify the user needs, bring up idea's to meet the needs, evaluate the solution and adapt or adjust this, if the problem is not solved or new problems occur. They all emphasize the personal attention to the special needs of the PwD and his lifestyle and have an iterative character. Most PwDs need to be evaluated regularly, since properties of the human body and the needs of PwDs are constantly changing. Hereby we also should recognize that it takes professional skills to apply these methods, and that the use of the provision of a wheelchair on itself does not help the PwD. Besides the provision there is a need for technical and practical training for PwD and caregivers.

VI FURTHER READINGS AND REFERENCES

During the literature research a lot of interesting websites, literature and organizations were found that can be a great help for all people that are involved or interested in disability related information. The majority of the information is about wheelchair design and disability studies but on the sites a lot of general information can be found about related subjects. This appendix gives an overview of the found sources with a description of the information available. Because a lot of literature can be found in a digital format on the Internet the websites are mentioned as well. Since websites of organizations change from time to time it is possible that they can not be found after a period of time. Unfortunately this can not be avoided.

Wheelchair design in developing countries

Whirlwind Wheelchair Network

Whirlwind is the name of a famous design made in 1980 by Ralf Hotchkiss and members of the Organization of Disabled Revolutionaries (ORD) in Nicaragua. This resulted in developing low-cost wheelchairs for the Third World, using "appropriate technology." Since helping ORD in Nicaragua, Ralf has travelled around the world, facilitating workshops and helping groups of disabled persons begin to produce appropriate wheelchairs. Ralf has led workshops and worked with disabled wheelchair builders in 30 countries in Latin America, Africa, Asia, and Russia. (David Werner, 1998)

<http://engineering.sfsu.edu/centers.html>

<http://www.cimnetwork.org/engineering/wheelchairs.cfm>

David Werner

David Werner has worked in more than 50 countries-mostly in the Third World-helping to facilitate workshops, training programs, and approaches to "health education for change." He has been a consultant for UNICEF, WHO, the Peace Corps, UNDP, UN-ESCAP, World Bank and various state and federal governments ranging from Mexico to India and Iran. He published several books on disability and health related subjects.

<http://www.dinf.ne.jp/doc/english/global/david/dwe001/dwe00101.htm>

<http://www.dinf.ne.jp/doc/english/global/david/dwe002/dwe00201.htm>

Motivation

Motivation is a partnership organization of local disability organizations that understand the needs of their own communities, to implement projects that enhance the lives of people with mobility disabilities. Their programs aim to improve opportunities for people with mobility disabilities by positively impacting on their physical, social and economic situation, resulting in greater integration into the community. Activities include the design and provision of low-cost mobility products (wheelchairs, tricycles and artificial limbs), capacity building and training with disabled people's organizations and rehabilitation institutions, rights based initiatives, employment programs and community based peer group training. The outputs of our partnership activities are designed to improve opportunities and build a local knowledge and technical skills base which enables disabled people and their organizations to address the quality of life issues in a long-term sustainable way.

<http://www.motivation.org.uk/>

Disability studies on Asian countries

United Nations (UN)

On initiative of the United Nations, several country studies have been performed. The activities of the UN can be found on the website Enable. <http://www.un.org/esa/socdev/enable/>

On the site of ESCAP and FAO digital version of previous publications can be found. These websites and document contain information on various aspects of disability in Asian countries.

<http://www.unescap.org/esid/psis/disability/decade/publications/z15001p1/z1500101.htm#contents>

<http://www.fao.org/sd/PPdirect/PPre0035.htm>

Asia-Pacific Development Center on Disability (APCD)

The "Asia-Pacific Development Center on Disability" (APCD) is a regional center on disability, as a legacy of the Asia and Pacific Decade of Disabled Persons 1993-2002, under the joint collaboration of the Government of Japan and the Government of Thailand. The website shows a collection of country profiles of Asian countries, including all the interest organizations of governmental and non-governmental organizations.

(<http://www.apcdproject.org/index.php>)

Association of Mobility Providers

Organization with website and links to INGO involved in the provision of assistive technology

http://www.rocwheels.org/Mobility_Providers/links.htm

Websites on Disability in Thailand

(www.rehab.go.jp/English/whoclbc/DoF/FacilitiesinThailand.html)

(<http://www.apcdproject.org/countryprofile/thailand/Association>)

Information on Public health nursing

Kasinee Wuddhiwong, Faculty of Public Health Nursing, Payap University,
Amphur Muang, Chiang Mai 50000

Wheelchair design and selection

Boninger, M., Baldwin, M., Cooper R., Koontz A., Chan L. (2000). Manual Wheelchair Push rim Biomechanics and Axle Position; volume 81 page 608-613

Hobson, D. (2003). Towards a Standard for the Definition and Measurement of Wheelchair-seated Posture Sweden. Stockholm, University of Pittsburgh

http://www.wheelchairnet.org/WCN_WCU/SlideLectures/BC/WTSD_london.html

Karp G. (1998). Choosing a wheelchair: a guide for optimal independence Sebastopol: O'Reilly & Associates

Design parameters for children's wheelchairs.

http://whirlwind.sfsu.edu/general_info/kids_project/design_params.html

Website with a variety of information on wheelchairs, wheelchair research, history and design, measurements systems, American standards from the University of Pittsburgh and the wheeled mobility research center.

<http://www.wheelchairnet.org>

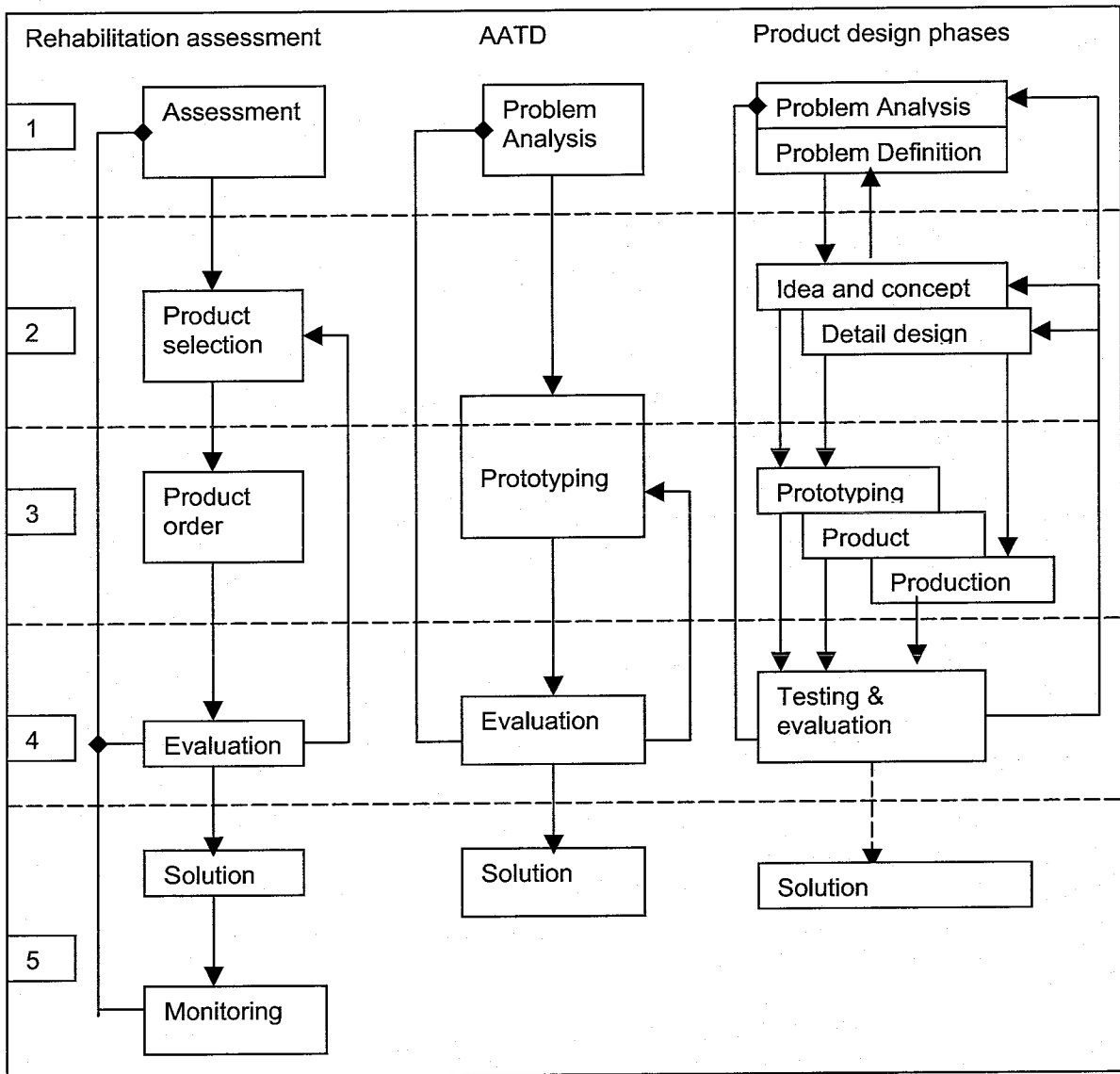


Figure H. Comparison of models

VII. CREATION OF THE RESEARCH MODEL

This appendix compares the different processes of rehabilitation assessment (RA) (Mayall, 1995), Appropriate Assistive Technology Design (AATD) (Hoff, 1993) and the major product design phases. This is done to find similarities and differences in the processes to be able to make a new model, which contains the most relevant aspects in the wheelchair provision process. In all the structures a flow can be seen from top to bottom. By following the structures two things can be achieved. First of all the problem is often not well defined, so a rough idea becomes a more detailed idea. Secondly there is a change from an imaginary idea to a physical device. Here the models are ordered from imaginary idea to physical device.

The transition from an imaginary idea to a physical device can be realised by executing the different activities. All activities start with a problem analysis and definition. In rehabilitation this is called assessment, because during the assessment of a PwD, the needs of the PwD define the problem that should be solved with a device. In the second phase, the idea's and concepts, to solve the problem arise. In RA, the idea's for solutions are a choice out of the existing products. A designer will get some ideas from existing products and come up with new ideas. In the third phase, the ideas get a physical form. In RA this is the product that seemed to be the best solution would be ordered at the manufacturer or taken from stock. In product design prototypes are often the first physical device. In the AATD problems are often solved very pragmatic. There is no explicit phase of ideation. Apparently the problem definition is the result of earlier activities and the ideas of improvement will evolve during the process of building the next device. The fourth phase is the evaluation. All methods use the evaluation to see if the problem is solved, or if a repetition of activities is necessary. The evaluation is done with the problem analysis. If the problem is not solved, or new problems have occurred, the second phase should be reviewed again and from there the process can continue.

The product design and development phase is a much more complex proces. First ideas are turned into concepts and prototypes are used to see, if the products function. This is tested by a prototype. If this is the case, the concept will be detailed and the product becomes more definite. In the same time, theproduction of the product is considered. Due to the influence of the development of computer technology is it possible to keep the desing a virtual process.

Conclusion

All the models have a similar structure, but differ in the way iteration takes place. A design and development process has much more iteration. Since the model is used for all the rehabilitation situations all the iterations have to be put in the model. Five phases with comparable activities can be defined, but the phases can not be strictly divided, because there is an overlap between activities. To be able to compare the different methods and models the phases have to be introduced. The five resulting phases are: the problem phase, the ideation, the product phase, the evaluation phase and the phase of operation. They are shown in Figure C.

A closer look at rehabilitation assessment

The study of the design theories showed that a lot of products do not meet the needs of the customer, because the problem is not carefully investigated. After the examination of the model of Mayall and the comparison of design models a structure is found. Here the models of assessment are examined more carefully to get a better understanding of the activities. The practical cases from fieldworkers did not provide a method of assessment and the literature on assistive technology design is not focused on the design of wheelchairs. The problem analysis is the stage in which the problem is analysed and formulated. Here the problem consists of 2 paths. First path is the social problem of the PwD in the given situation, to get an impression from the PWD and his needs. The second path is the technical problem of how technology can provide a solution. The PWD data collection and the needs inventory give a better understanding of the social problem, while the technological data and the technological possibilities reflect the technological problem.

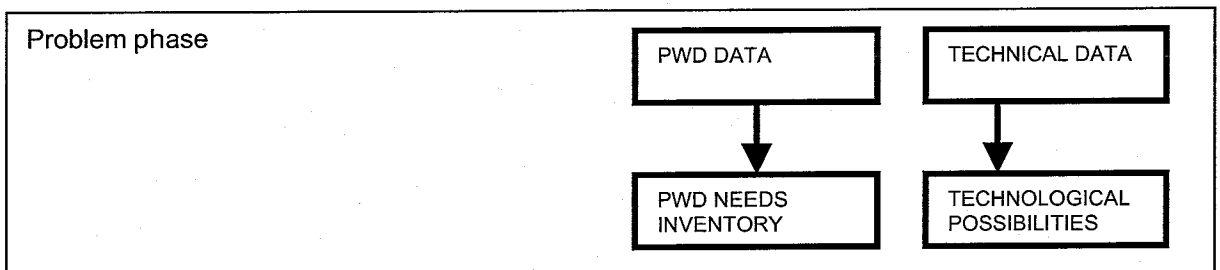
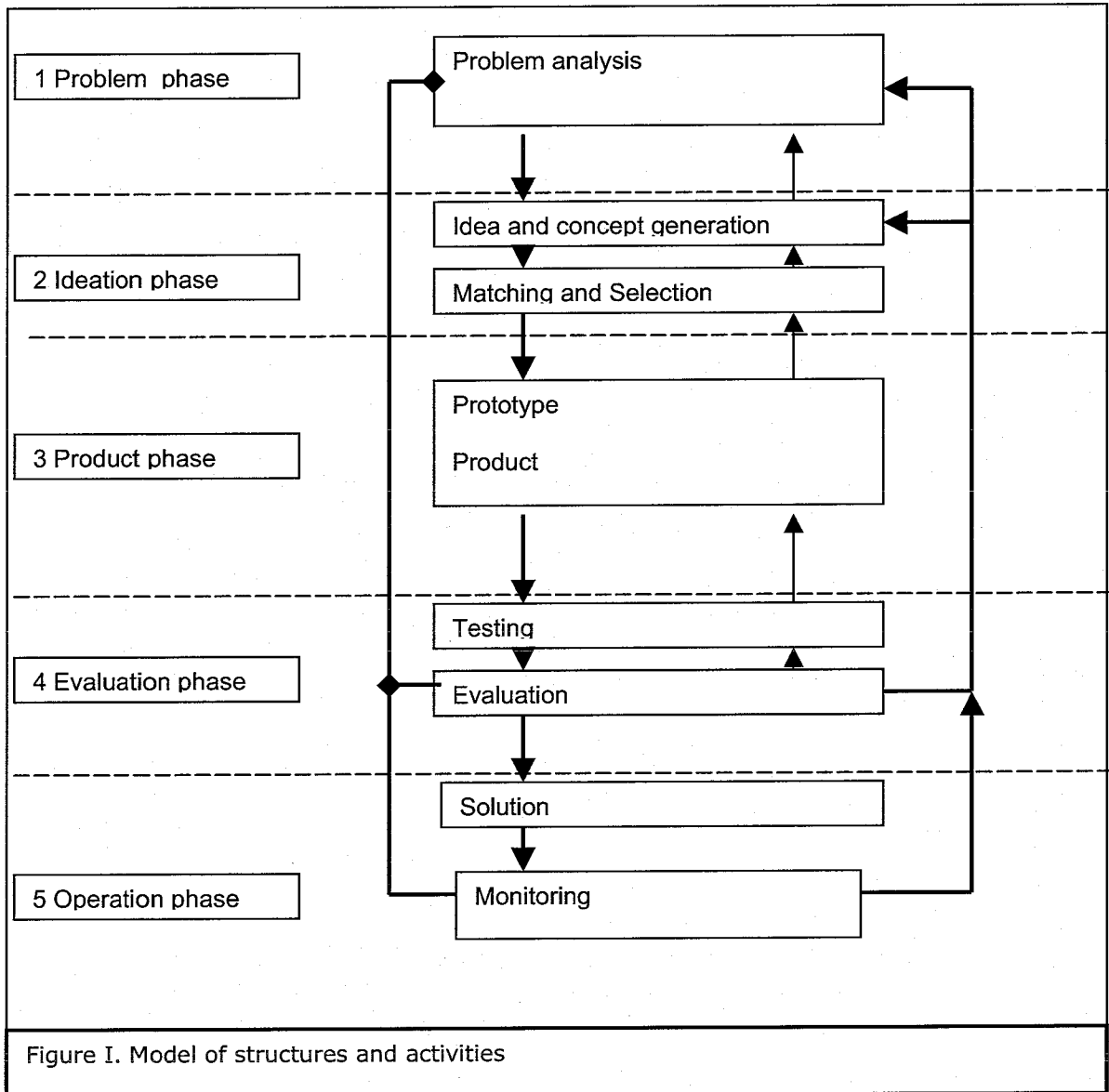


Figure J. deviation of the problem phase

The data collection and the needs inventory are often done in the same time as the needs inventory, because a rehabilitation specialist is capable of translating the data of the PwD in the needs. Sometimes the PwD and caregivers can express their own needs. Since the problem has to be solved by building or adapting a wheelchair, it is necessary to stay informed about the technological status. Recent design and production methods can create new technological possibilities in the given situation.

The PwD data collection and needs inventory can be registered with the classification of the International classification of functioning, disability and health (ICF) (WHO, 2001). For the technical data collection and technological possibilities the product technology and production technology can be examined and used to categorize the necessary information considering technoware, humanware, infoware and orgaware. ((Van Egmond, 1998 p. 13, Ch1: ESCAP, 1989, p. 111)

Rehabilitation Assessment: Data collection and PwD Needs

The first step in problem definition is to gather information, mainly on personal factors and the living situation of the PwD. Basic key questions of assessment are:

- How old are you?
- Do you live alone or with others? If the respondent lives with others, ask: In what ways might they be -helpful or a problem?
- What is your occupation?
- How far is your house from this workshop? If the distance is more than is convenient for the respondent, ask: How did you get here? Do you plan to go back today? If not, how will you manage overnight accommodation?
- What disability are you looking for help with?
- What caused it? How old were you when this happened?
- Have you had an assistive device before? If the answer is yes, ask: When did you get it and how long did you have it? What were the good and bad aspects of wearing it? Who prescribed it for you?
- What do you expect a new assistive device will be like?
- What do you want to be able to do with it?

The answers on these questions should give a clear view on the environmental context, the position of the PwD and the way he lives (Drouet, 1997). The next step is a medical examination. With a clinical examination, supine math assessment, and seating evaluation the body functions, structures and measurements can be investigated. During these examinations the needs for body fixation and support become obvious. This should result in a list of supporting surfaces that represent the way a wheelchair should fit. The last step is to consider the needed properties of the seating and the base of the wheelchairs. Here the needs of mobility for activity, participation and the independency of the PwD play an important role (Bergen 1998). This part should guarantee that the need for mobility is fulfilled. After the assessment, the ideal properties of the wheelchair should be obvious. Together with a rehabilitation engineer, representative from a wheelchair manufacturer and seating supplier a suitable wheelchair can be composed. Here information on the technological possibilities must be available as well.

Technical Data collection and technical possibilities.

The technical possibilities that are proposed are heavily dependent on the involved person who should determine the assistive technology device. Limitations in technological capabilities, financial limitations or limitations on type or brand provision due to legislation or business contacts may force the provider to choose for a less optimal situation. To be able to come up with the best solution possible the facilitator should keep himself informed on product and production technology. The technical data collection refers to technoware and infoware, which are known by the involved facilitators. The technical possibilities refer to the actual ability, to design new products and produce them. These are restricted by the technoware, infoware, humanware and orgaware (ESCAP, 1989p. 109-111). After the PwD data and needs and the Technical data and technical possibilities are clear, the phase of ideation can start. Figure E shows the result of the research.

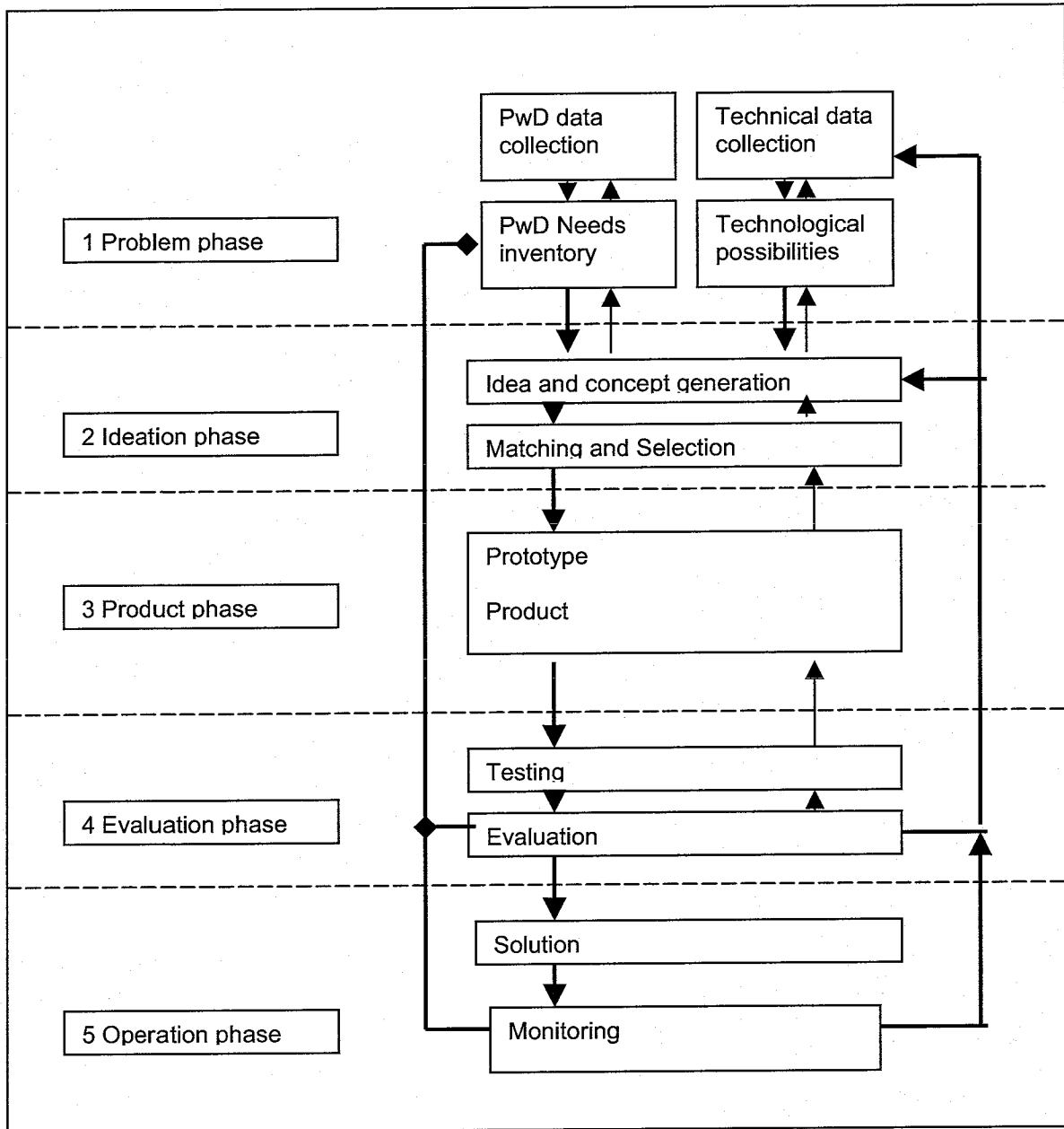


Figure K. The research model

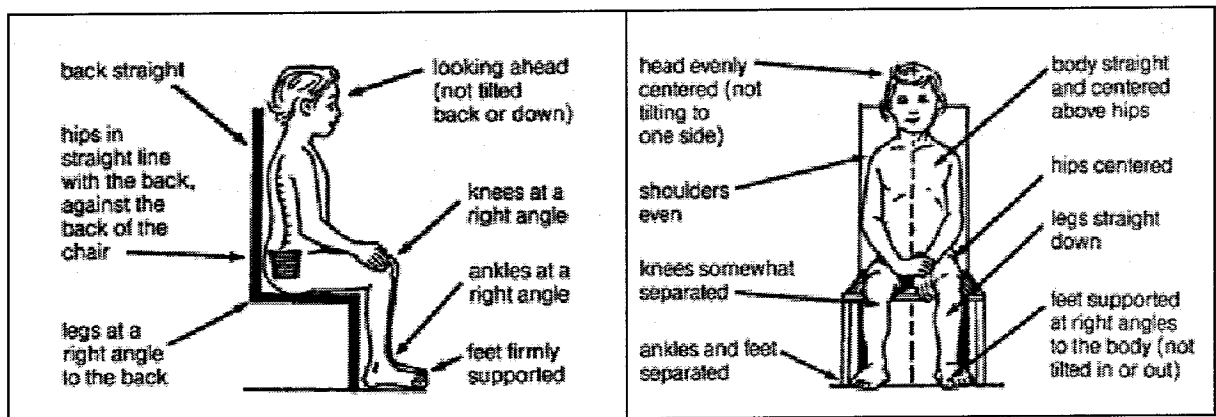


Figure L. Guidelines for evaluation of optimal body position for seating (Werner, 1960, Ch. 64)

The research model explained

To get a better understanding of the related factors during the activities more detailed explanation of the different activities is given. During the literature search a number of tools and methods were examined. These tools provided the indicators, used to check if the activities were executed. The tools are a way of executing the activities. If the research shows that certain activities are not executed or execution gives problems, then the tools can be a way of solving the problems. With the examples and figures, the theory is illustrated, to be able to understand what can go wrong if certain activities are not executed according to the minimum of activities represented in the research model.

Phase 1 Problem analysis

Activities

The PwD data collection is the execution of the activities to collect the relevant data on the individual. This is the actual registration of the data. The collection of data can be organised with the classification of ICF, as described in appendix X (WHO, 2001). Arrow 1 represents the translation of data into needs. The data on the PwD can be translated into needs. The personal data tells something about his position in society and needs in daily life. This can indicate the mobility needs for daily activities in and around the house, social interaction, education and employment. After the needs inventory, the data can be used to come up with ideas that meet the needs (arrow 2). The needs inventory can be the result of the translation and combination of the data mentioned above in needs of the PwD. In other situations the needs can also be collected by observation or interaction with the PwD. A personal conversation with the PwD and his primary caregivers give a better understanding of the social wishes of the PwD. For the inventory of the medical needs a number of tools and methods are mentioned below. A clinical assessment, observation of PwD in his current wheelchair or seating evaluation can result in stability needs.

Personal factors determine the social position of a PwD in society and the needs concerning mobility needs for the participation to social activities, education and employment. The cultural habits and the role of a person in the community and environment all have to be considered. In many traditional Asian and African cultures, people are used to do a lot of activities are done on floor level while in many western countries a chair and table is used for body support, to prevent sitting on a cold floor or dirty floor. In other countries people learn to sit, on floor level, without touching their bottom on the floor. To keep dirt outside the house, the whole floor level is lifted and stairs make the house accessible. While providing a wheelchair the infrastructure, local housings style and sitting habits must be examined (UN, 1997 part 1 chapter 3). The easiest way to collect such information is by observing the actual situation. The activities mentioned above can take place in the living area of the PwD or at the location of an institution. Medicals will prefer an assessment in the institution, but often fail to notice the environmental needs.

Tools and methods

The data can be classified according to the ICF into personal factors, body functions, body structures, body measurements, activities and participation and external factors (WHO, 2000). This data can be collected with a personal interview of the PwD, a clinical assessment; by observing the client in his current wheelchair. During a supine math measurement, the measurements and available range of motion can be observed. Because the gravity on the body is minimized, the optimal position can be observed. During a seating evaluation in the current wheelchair, on a simulator chair or alternative, the objectives for each body part can be set (Bergen, 1998). Here first we can look at the stability needs and the mobility needs. The stability needs is the need of the body support, while the mobility needs is the ability to move freely. These needs differ from individual to individual, because they depend on the data mentioned above. The body support is necessary to keep the body in a healthy position, while this should not limit the movability of the body or cause damage to the body. In general the following guidelines can be used (see figure L). A wheelchair should improve the body orientation. Eye contact, optimal pelvic position, spinal alignment and trunk balance are the main aspects. Such a position guarantees an optimal function of gastrointestinal and cardiopulmonary system. Only those elements of the body should be fixed that need to be fixed, to achieve a good position. All other parts should be able to move freely, to promote the normal development of motor skills. Sometimes compensation or

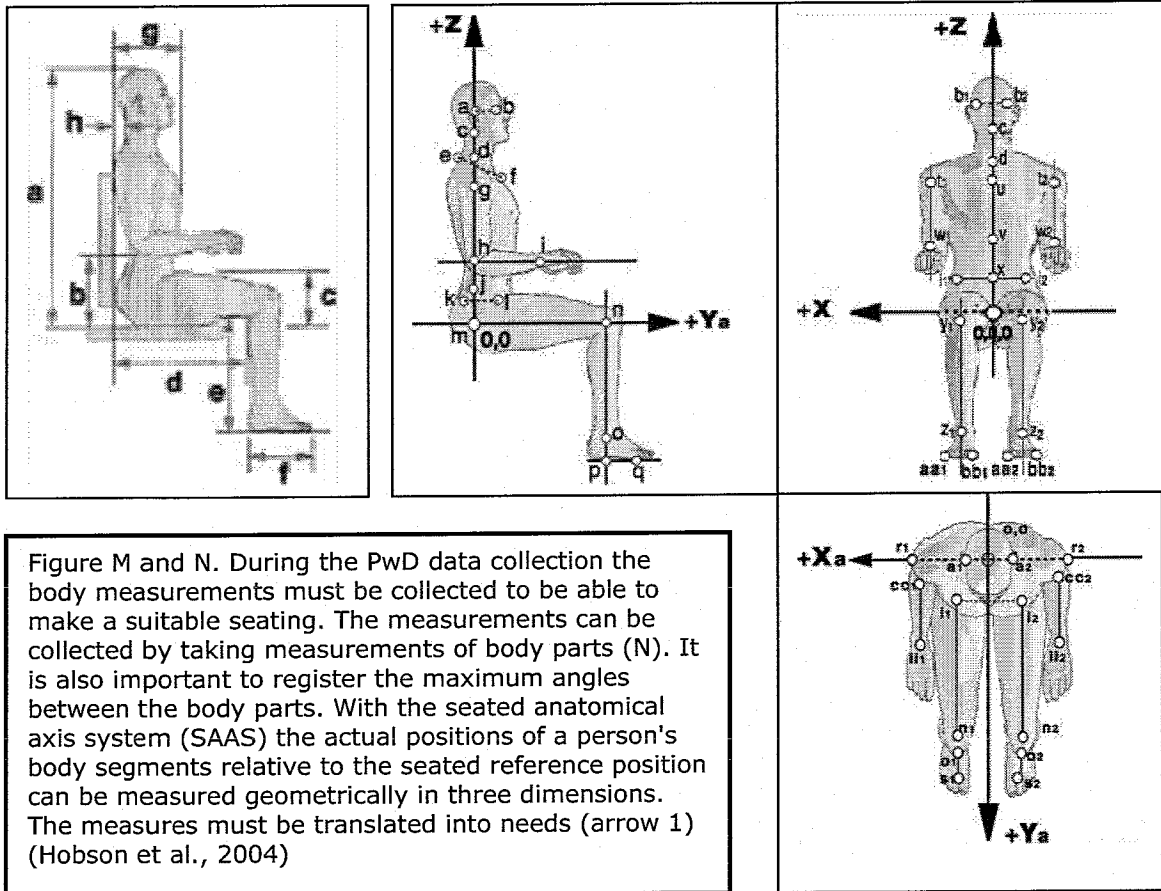


Figure M and N. During the PwD data collection the body measurements must be collected to be able to make a suitable seating. The measurements can be collected by taking measurements of body parts (N). It is also important to register the maximum angles between the body parts. With the seated anatomical axis system (SAAS) the actual positions of a person's body segments relative to the seated reference position can be measured geometrically in three dimensions. The measures must be translated into needs (arrow 1) (Hobson et al., 2004)

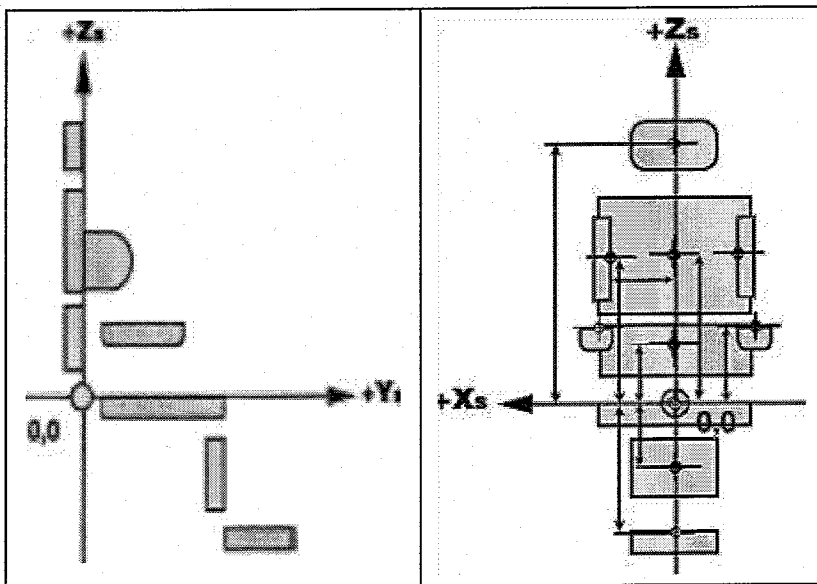


Figure O. The translating of the body measurement into the actual need of body support, fixation or mobility can be describe in the support surface axis system (SSAS). The seated reference position (SRP) defines a fixed hypothetical neutral baseline of seated posture to which other postures may be referenced. With this measurement system all the needs of support systems can be defined. It is an important part of the PwD needs inventarisation and can be used during the ideation phase. (Hobson et al., 2004)

delay of physical deformation of the body is possible. A seating position should improve the stability of the body and prevent sliding or leaning.

To visualize the body measurements and body support it is useful to standardize the measuring system and integrate the body measurements, needs for body support and eventually the configuration of the wheelchair. Figure M, N and O P and Q give examples of measurement systems of bodies, support systems and wheelchairs, which can be integrated in a single measurement system (IMS) system (figure P).

The lack of individual measurements and needs can make PwDs more dependent and even cause more harm. In other cases, the data will not be collected as such, but only the needs will be registered. This makes it impossible to reinterpret the data and transform it into needs, if more people work on the same individual. If no assessment is done and measurements of the body are ignored, the chance of providing a suitable wheelchair is very small.

Technical data collection and technological possibilities

Activities

Technological data is all the information available to the actors that is available to realize the production of assistive technology devices. The technological possibilities are the product and production technology, available and applicable in the given circumstances. This is the mix of product technology and production technology, which should result in the production of the assistive technology devices. This data can be divided into data about product technology and production technology. Product technology is defined as the body of knowledge, ways and means, which is applied for the design and specification of the goods and services to be produced. Production technology are the skills and knowledge embodied in machines (technoware), man (humanware), information (infoware) and organization (orgaware), applied for the production of goods and services required by a society in which and by which it is being used. (Van Egmond, 1996 p. 13, Ch1)

Tools and Methods

A variety of data collection methods can be used to gather information about wheelchair technology. Active ways of data collection are networking, organization and visit of conferences, searches on internet or a literature study. company visits, workshop visits, inventory of local skills, examination of locally produced devices or by technology transfers.

The awareness of which data is relevant and which possibilities are available differ from the actors knowledge and awareness and the technological status of the environment. The data can vary from manuals of manufacturing machinery, where technological possibilities of the machinery is explained. In other cases, the machine operator has the knowledge. Also the total of previous produced devices

Besides the necessary skilled technician and management (humanware) to keep the production going the information, the employees must have the necessary production drawings, sketches, models and production procedures (infoware) Technological possibilities depend on the available tools and production equipment.

For the production of wheelchairs there is a minimum of machinery and tools necessary to be able to produce a wheelchair (technoware). The tools needed is dependent on the base material that is used. For the production of wheelchairs from steel or aluminium a the following tools and skills are needed:

- measuring tools
- metal saw
- bending equipment
- hammer
- bench vice
- file
- brass welding or arc welding device
- angle grinder
- hack saw
- hand drill and column drill
- sewing machine,

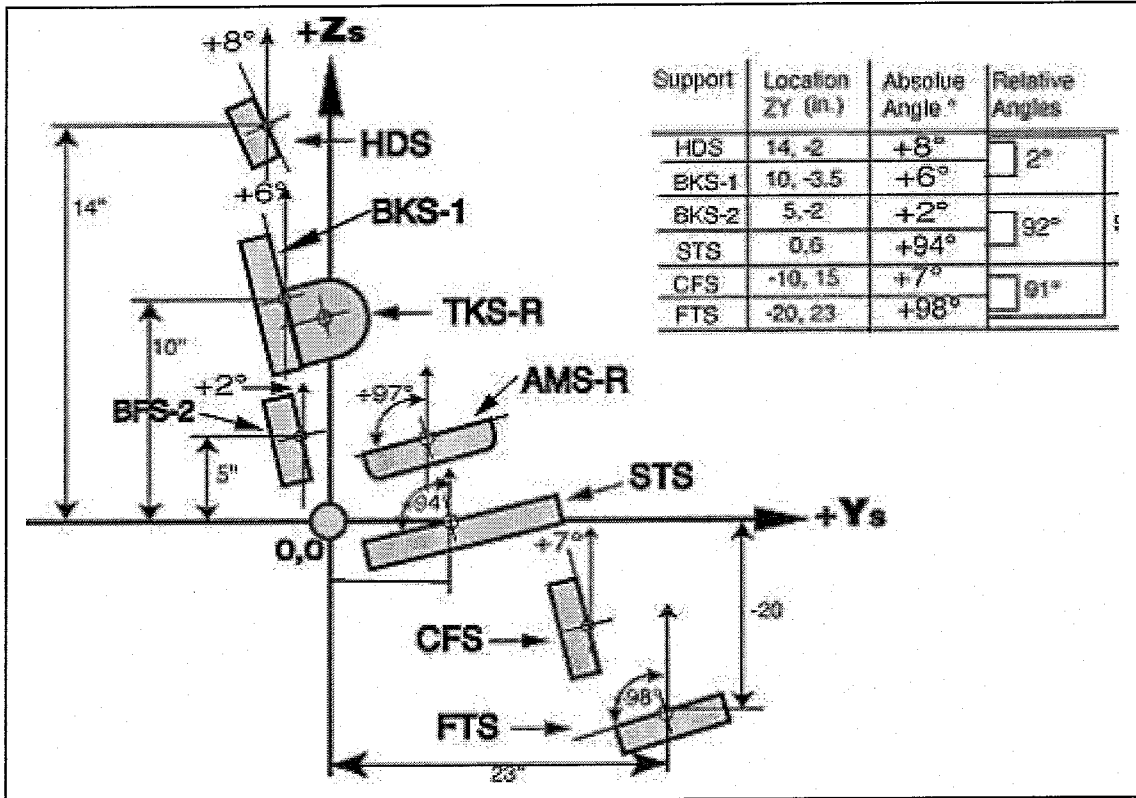


Figure P. The integration of the measurements and PwD needs results in an overview of the support surface measures (SSM). (Hobson et al., 2004).

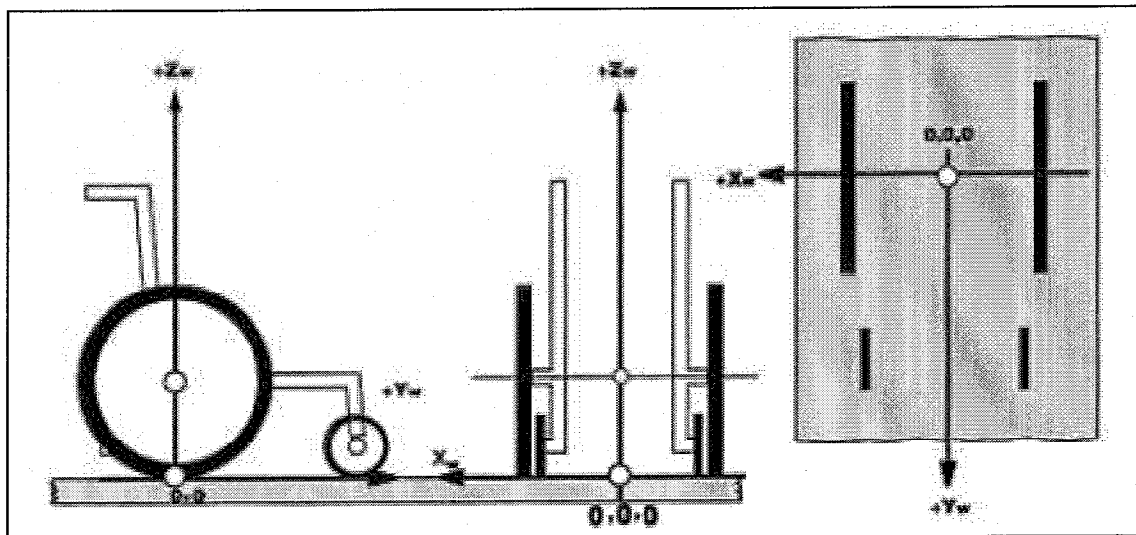


Figure Q The Wheelchairs Axis System (WAS) is the measurement system of the wheelchair configuration. With this system the basic measurements of the frame and wheels can be registered. Here the stability and manoeuvrability are important.

- scissors
- screwdrivers
- wrenches
- Allen keys
- pliers

In most cases the frames of the wheelchairs are finished by a cover of paint. This can be done by brush or spray paint. Some companies use paint baths, powder coating or anodise certain parts. Sometimes activities are not done internally, but external companies assist in the production of parts. In general fasteners, bolts washers nuts and wheels are bought.

The way in which the hardware, humanware and technoware are organised (orgaware) determine if the production is actually being fruitful. This can be measured by comparing the productivity of a factory.

Tools and methods

To guarantee the production of qualitative good products the production procedures must be obvious. This can be done by production manuals and drawings. In small workshops, a lot of knowledge is often not documented. Sometimes information is embedded in the production examples, production templates and jigs. The data available must be interpreted by the actors involved. Therefore the employees must have sufficient training to be able to understand the procedures.

The major organizations, worldwide active on spread of information about wheelchair production are Motivation and WWI. (Appendix 5 Appropriate assistive technology:- the fieldworkers). Many cases have been collected by David Werner and published. They are also available on the internet.(Werner 1998) Many universities have access to a variety of information sources. For a small fee, many library officers are willing to help to search for information.

Phase 2 Ideation

Activities

The ideation contains the idea and concept generation, matching and the selection. During the ideation the needs of the PwD are integrated with the assistive technology available. New ideas may be generated, or existing solutions may be combined. Partial solutions are found for the different needs and combined into concepts. After the generation of the functional ideas, on body stability and mobility, and the generation of technical ideas, taken from the technological possibilities, they can be matched. During the selection and matching, the possible solutions are valued and selected. The different ideas and concepts are selected with the social needs and technological possibilities as a reference for criteria. The process is often highly iterative, since many ideas can be available and different actors are involved in the selection.

In most cases the selection of ideas is based on intuition or experience. A safer method is checking if the wheelchair meets all the needs of the PwD. In many small workshops, the cost and time aspects play an important role, and limit the possibilities. Another method is making a list of partial problems and the priorities to solve them. For the production a number of selection criteria can be used. Material and tools for production, maintenance and repair should be locally available. The end product and spare parts must be affordable for the local population. If possible, use standard material and parts, like bicycle parts,

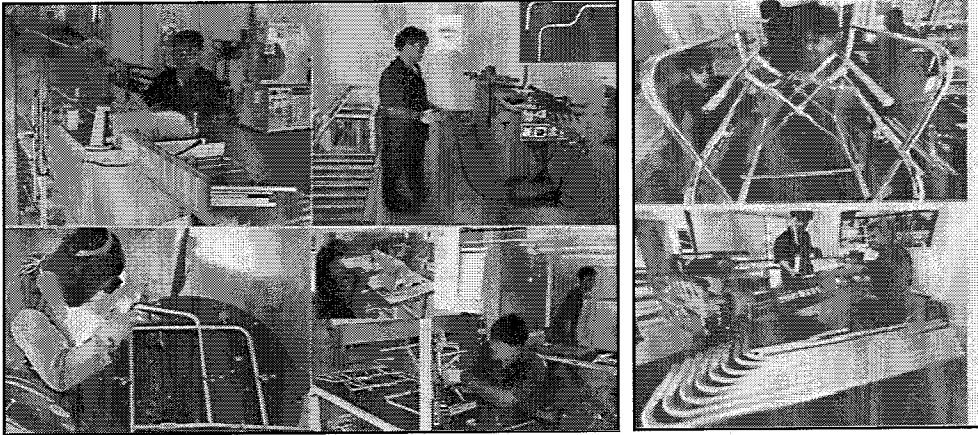


Figure R. Wheelchair production at THAIWheel.



Figure S. This wheelchair is produced with limited knowledge about design, construction and the used materials are not carefully chosen. This results in an uncomfortable unsafe wheelchair. The axles are too weak and will bent during use, the material used for the brakes is weak and the brakes do not press against the tires, but stay in position because the chair is sprayed with the brakes on the frame. The backrest is assembled upside down and behind the tubes, instead of in front of the tubes. Canvas is used for the footrest. This will become wet, and rot away. Tubes and profiles are not de-burred and still rough, which will lead to skin irritations and cuts.

Phase 3 Production

Activities

The production is the phase where one or more devices are manufactured. The devices can be a prototype or product out of an existing stock. It can also be a combination of e.g. existing models and new designed seating or accessories. This includes activities, customizing and adapting

Tools and Methods

A diversity of production methods have been developed for the production of assistive technology devices. Traditionally wheelchairs were made of stainless steel. Frames were connected with brass welding. The number of steel wheelchairs is decreasing, in favour of aluminium models. Aluminium is much lighter, which makes a wheelchair easier to operate. Other base materials are wood, PVC and bamboo. These materials are much cheaper and skills to shape the material are often available under the rural population. In brief, the following the stages can be seen in manufacturing:

Preparation

The parts and raw materials have to be order. Drawings have to be made or workers have to discuss with each other how things can be made. They have to set up the machinery. In some workshops they have to install templates. In others the machinery needs to be adapted to material properties.

Fabrication of parts

The raw material has to be cut on the needed sizes and often a series of additional operations, like bending, cutting, drilling and the removal of sharp edges, in order to get the specifications.

Sub assembly and Assembly

The parts have to be connected to subassemblies. Subassemblies have to be connected to create the complete product. Typical subassemblies of a wheelchair frame are the process of welding the parts of the frame, the production of the seating system and cushions. During the assembly all the parts are connected. The bearings are placed and the wheels are tightened, seating systems are fixed to the frame, the brakes are put on and accessories are fixed.

Finishing

Often parts have to undergo a certain finishing, to make the base material more durable and preventing degradation of material by influences of the weather. Corrosion can be prevented by painting the material.

Quality check/test

The finished product must be tested, to control if all parts have been made according to the specifications and to assure that the product is safe. Play on the bearings, the resistance of the breaks, air pressure in the tubes and a test on equal resistance on the left and right side of the wheels should guarantee the safety and comfort of the new product.

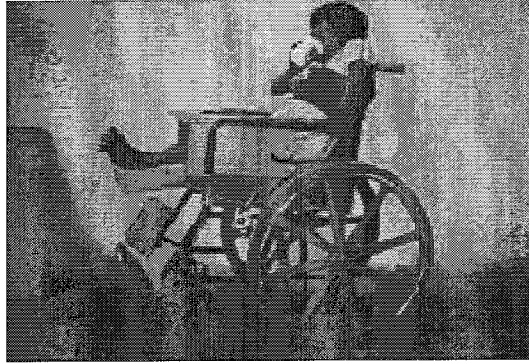
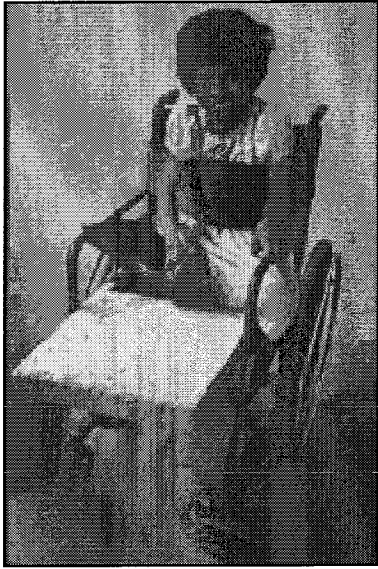


Figure T. Rufina was first put in a regular chair with extra cushions. Rufina's body arched up stiffly. Rufina was placed in the chair with positive seating, but it made the contractions worse. Rufina made it clear that she felt more in control in her own chair. Further observations and trials in her oversized chairs made the team realize that one problem was that her right knee hooked over the front edge of the seat. That caused her to move forward. The wheelchair was adapted, by placing a long padded board on the seat, to extend her legs straightforward. Rufina felt uncomfortable, if she had to sit with her legs straight the whole time, so she folded them. The wheel guards made this uncomfortable, so they were removed. Now she could sit and move her hands. So, after a series of trials and errors Rufina could sit comfortably. A table was placed between the armrests, so she could eat by herself. (Werner, 1998)



Figure U. The child from Angola, suffering from a spinal cord injury was given an oversized wheelchair as well. Instead of doing good, it has caused a deformation of the spinal cord. The original footrests did not support the feet, resulting in high pressure on the buttocks. Since no cushion was provided, skin problems might occur. The cushion in the back makes the child sit more foreword, to prevent pressure of the seat in the knee-pits. Although the child can move his arms and shoulders, it is impossible for him to propel the chair, since he can only touch one wheel. (Werner, 1998)

Phase 4 Evaluation

The evaluation consists of device testing and evaluation. In this phase the actual usability of the device is judged by testing it. Device testing is the stage where the device is used in order to determine how well it works. Besides the technical prototype testing on strength and safety, the product can be tested on the performance in the actual situation of daily usage. This can be done by user task analyses, after the training of the user (Poulson, 1996). The PwD can use the device in the actual environmental setting or a controlled situation can be simulated. The results of the testing should be evaluated (arrow 8). Device evaluation is the assessment if the device can meet the specifications of the social needs (arrow 9) and technological possibilities (arrow 10). If the social needs are not met, than new ideas should be made or the social needs and technological possibilities should be re-examined. It can also occur that the specifications of the social needs are met, but that this does not resolve the actual problem. In that case the tests and evaluations can also result in new demands and wishes that were not in scope before. In that case, the problem analysis should be reconsidered and phases should be repeated (arrow 16 and 17). If the tests and evaluation give a satisfied result, than the mayor solution of the problem is found. The major solution can be defined as the stage of successful action of solving the problem on the short term.

Examples

The case of Rufina shows the pragmatic approach which is often necessary to find the balance between the many different needs of an individual (Figure T). Unfortunately, the case of Rufina shows only a solution of a partial problem, caused by the wheelchair in the first place. In this case the wheelchair places her on a higher level and gives her a comfortable seating position. It is not tested, if Rufina was capable of propelling a children's wheelchair by herself. Figure U. shows a boy from Angola. He was never evaluated, which resulted in further deformation of his spinal cord.

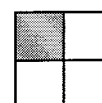
Phase 5 Operational phase (operation)

The operational phase is the time in which the device is used by the PwD and Caregivers. It is the daily use of the product in their environment. Due to the constant changes of the body structures, measurements and personal condition of the PwD and caregivers a social/medical follow up is needed. Of course also the condition of the assistive technology device can change over time. Therefore there is always a need for monitoring and follow up. Monitoring is the regularly contact, interaction or observation of the PwD and his device, to be able to assess if the device is still functioning according the specifications and the demanded major solution. This includes overall assessment of the PwD, overall assessment of state and functioning of the assistive technology device and control on necessary maintenance and repairs. If a device is not functioning according to the specifications, or if the user needs have changed in such a way that normal maintenance and adjustment does not result in a solution, than follow up is needed. This means that the assistive technology device should be changed or replaced. In that case, there should be a repetition of the previous phases (arrow 14 and 15). The best way of monitoring is by visual control and interaction with the disabled and caregivers. The exact way often depends on the distance between the PwD and actual service provider. CBR-teams and outreach services can visit PwDs or PwDs can travel to the facilitators.

VIII OPERATIONALIZATION OVERVIEW

Operationalization of the research		
Activity	code	Classification
PD PwD data collection	1	personal factors
	2	body structures
	3	body functions
	4	body measurements
	5	activities & participation
	6	technical skills and tools
	7	(by humans changed) Natural environment
	8	support and relations (primary caregivers)
	9	willingness to help by strangers
	10	local social support
NI Needs inventory	11	body part fixation
	12	body support
	13	body mobility
	14	muscle strength for independent propelling
	15	activity & participation
	16	indoor mobility
	17	outdoor mobility
	18	family support
	19	community support
	20	local support needs
TDC Technical data collection	21	product technology (T)
	22	product technology (I)
	23	production technology (I)
	24	production technology (T)
	25	" "
	26	" "
	27	" "
	28	" "
	29	" "
	30	" "
TP Technological possibilities	31	product technology (T)
	32	product technology (H)
	33	product technology (I)
	34	product technology (O)
	36	production technology (T)
	37	production technology (H)
	38	production technology (I)
	39	production technology (O)
	40	production technology (O)

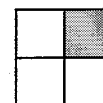
Table 1A. Operationalization overview part A



APPENDIX VIII

See appendix		
Indicators	Indicator details & reference	code
personal factors	ICF, table 1	1
body structures	ICF, table 2	2
body functions	ICF, table 3	3
body measurements	ICF, table 4	4
activities & participation	ICF, table 5	5
possibility to adjust, repair, maintain	ICF, table 6	6
dirt and mud, angle of slopes	ICF, table 6	7
help by indoor and outdoor activities from caregivers	ICF, table 6	8
help by outdoor activities	ICF, table 6	9
organizations for community support	ICF, table 6	10
body part fixation	Bergen, 2000	11
body support	Bergen, 2000	12
body mobility	Bergen, 2000	13
muscle strength for independent propelling	Bergen, 2000	14
(mobility) needs for activities and participation	Bergen, 2000 / ICF table 5	15
independent during indoor activities	Bergen, 2000 / ICF table 5	16
independent during outdoor activities	Bergen, 2000 / ICF table 5	17
mobility dependence family or caregivers	Bergen, 2000 / ICF table 5	18
mobility dependence on community support	Bergen, 2000 / ICF table 5	19
help by organizations for community support	Bergen, 2000 / ICF table 5	20
drawings, models or infrastructure or network to get them	ESCAP, 1989	21
brochure, literature	ESCAP, 1989	22
production drawings, processes, procedures	ESCAP, 1989	23
order of parts and base material in stock		24
material preparation		24
assembly precision		25
subassembly-assembly		27
finishing, painting achromatizing		28
inspection of safety and quality		29
delivery and service with manual and guarantee		30
number of new designs or accessories	ESCAP, 1989	31
skilled designers/technicians	ESCAP, 1989	32
drawings, sketches, models of wheelchairs & accessories	ESCAP, 1989	33
number of new designs actually implemented	ESCAP, 1989	34
tools and machinery	ESCAP, 1989	36
skilled technician and workers	ESCAP, 1989	37
production drawings, processes, procedures	ESCAP, 1989	38
capacity of production/donation in wheelchairs per year	ESCAP, 1989	39
actual production/donation time of wheelchairs	ESCAP, 1989	40

Table 1B . Operationalization overview part B



APPENDIX VIII

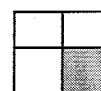
I&CG	Idea and concept generation	41 42 43 44 45 46 47 48 49 50	ergonomics adjustability adaptability usability durability corrosion maintenance skills cost appearance
M&S	Matching and Selection	51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	ergonomics ergonomics appropriate support surface ergonomics: ability to propel ergonomics: ability to propel adjustability corrosion / durability durability durability manoeuvrability safety usability usability maintenance maintenance maintenance maintenance maintenance appearance resulting usability
P&DP	prototype & device production	71	production
	Training and Testing	81 82 83	producer expectations PwD expectations improvement PwD skills and knowledge
E	Evaluation	91 92 93 94	updating, refining and comparing within one month of delivery updating, refining and comparing within one month of delivery updating, refining and comparing within one month of delivery updating, refining and comparing within one month of delivery
M	Monitoring	95 96 97 98	updating, refining and comparing after one month of delivery updating, refining and comparing after one month of delivery updating, refining and comparing after one month of delivery updating, refining and comparing after one month of delivery

Table 1C. Operationalization overview part C.



body part fixation, support or mobility	Bergen, 2000 / ICF	41
of footplates, seat-angle, fixation straps, axle position	Bergen, 2000 / ICF	42
accessories possible	Bergen, 2000 / ICF	43
indoor mobility/ outdoor mobility	Bergen, 2000 / ICF	44
material properties	Werner, 1988/ UN 1997	45
material properties or finishing	Werner, 1988/ UN 1997	46
time interval for maintenance needs	Werner, 1988/ UN 1997	47
local support needs	Werner, 1988/ UN 1997	48
price of product (including overhead costs and maintenance)	Mayall, 1995;	49
change in colours/material since 2000 (2543 B.E.)	Poulson, 1996	50
optimal pelvic position (no sliding)	Bergen, 2000 / ICF	51
spinal alignment, trunk balance, eye contact (no leaning)	Bergen, 2000 / ICF	52
skin integrity (no wounds, skin irritation or pressure sores.	Bergen, 2000 / ICF	53
shoulder/push rim orientation	Van de Woude, 1989	54
axles width/chamber/seat width measurements	Van de Woude, 1989	55
variable angles and lengths of body supports	Werner 1988/ UN 1997	56
wheelchair adjusted to outdoor conditions	Werner 1988/ UN 1997	57
weight/strength	Werner 1988/ UN 1997	58
base material/ hours of use per day)	Werner 1988/ UN 1997	59
wheel configuration (3/4 wheels)	Van de Woude, 1989	60
brakes, material impact	Werner 1988/ UN 1997	61
frame choice (stable/ folding	Werner 1988/ UN 1997	62
seating choices	Bergen, 2000	63
material choice for cleaning	Werner, 1988/ UN 1997	64
bearing type	Werner, 1988	65
folding mechanism	Werner, 1988	66
air/massive tires	Werner, 1988	67
need of tools to adjust	Werner, 1988	68
not stigmatizing hospital , modern colours and materials	Poulson, 1996	69
see activities and participation		70
availability of prototypes/devices		71
test results on device properties -technical approach	demands	81
feedback from PwD	see activities and participation	82
improved skills by practical training		83
evaluation and feedback of user needs	arrow 9, arrow 16a	91
evaluation and feedback of PwD data	arrow 10, arrow 16b	92
evaluation and feedback to technological possibilities	arrow 11, arrow 17a	93
evaluation and feedback to technical data	arrow 12, arrow 17b	94
evaluation and feedback of user needs	arrow 14a	95
evaluation and feedback of PwD data	arrow 14b	96
evaluation and feedback to technological possibilities	arrow 15a	97
evaluation and feedback to technical data	arrow 15b	98

Table 1D. Operationalization overview part D.



IX RESEARCH INSTRUMENT

After the identification of the actors and clusters, the actual research can be done. This list of questions is the research instrument, retrieved from the indicators. The questions can be answered with yes or no. If a question is answered with yes, this means that the activity, or a part of the activity is executed. The questions were made in such a way that they can be used for several data collection methods. Behind the questions the reference is given for more information or classification.

	<i>Interview question (observation question)</i>
code	
1	Do you (does the actor) ask personal factors of the PwD?
2	Do you (does the actor) investigate body structures of the PwD?
3	Do you (does the actor) investigate body functions of the PwD?
4	Do you (does the actor) measure the length and angles of the body of the PwD?
5	Do you (does the actor) gather information on the activities and social participation of the PwD?
6	Do you (does the actor) ask the PwD or his caregivers, if they have tools to maintain the wheelchair?
7	Do you (does the actor) ask or observe if the house of the PwD is surrounded by sand roads, on angles and how the house can be reached?
8	Do you (does the actor) ask or observe if and who helps the PwD by moving inside or outside?
9	Do you (does the actor) ask if other people in the community are willing to help the PwD outside the house?
10	Do you ask if there are more organizations in the community for help?
11	Do you (does the actor) register the need for body part fixation?
12	Do you (does the actor) register the need for body support per body part?
13	Do you (does the actor) register the need for body mobility?
14	Do you (does the actor) test and register the muscle strength?
15	Do you (does the actor) ask how many miles the social facilities (school, work, temple, friends) are?
16	Do you (does the actor) ask if the PwD is independent, while doing indoor activities?
17	Do you (does the actor) is independent during outdoor activities?
18	Do you (does the actor) ask if the caregivers can help the PwD, if this is needed?
19	Do you (does the actor) ask the caregivers, if other people in the community can help the PwD, if this is needed?
20	Do you (does the actor) ask if the PwD or caregivers need or receive help from other organizations that offer community support?
21	Did you (did the actor) make new drawings, sketches or prototypes for new models since 2000 (2543 B.E.)?
22	Do you (does the actor) have information on wheelchair designs made after 2000 (2543 B.E.)?
23	Did you (did the actor) take new models in production since 2000 (2543 B.E.)?
24	Do you (does the actor) keep a stock of spare parts and material?
24	Do you (does the actor) clean, cut or campher the tube material before welding?
25	Do you (does the actor) assemble the tubes in a jig, or otherwise fit the parts for correct measurement of the frame?
27	Do you (does the actor) make sub assemblies of parts?
28	Do you (does the actor) finish the base material to prevent corrosion?
29	Do you (does the actor) inspect the finished product on safety and quality?
30	Do you (does the actor) provide a manual and give guarantee?
31	Do you (does the actor) make new designs?
32	Do you (does the actor) have skilled designers or technicians?
33	Do you (does the actor) have or have contact with skilled designers or engineers to obtain drawings, sketches, models, accessories or in some other obtain new designs?
34	Do you (does the actor) have implemented new designs since 2000?
36	Do you (does the actor) have the ability to use the tools and machinery to produce a wheelchair?
37	Do you (does the actor) trained employees to built a wheelchair?
38	Do you (does the actor) state the products in production drawings, processes and procedures??
39	Do you (does the actor) deliver a product within 2 months after the order?
40	Do you (does the actor) produce or donate more then 100 wheelchairs a year?

APPENDIX IX

41	Do you (does the actor) take body part fixation, support or mobility into consideration?
42	Do you (does the actor) take the adjustability of footplates, seat angles, fixation straps and axle position into consideration during?
43	Do you (does the actor) take into consideration if the wheelchair will need adaptations or accessories during the lifespan of the product??
44	Do you (does the actor) take into consideration if the wheelchair can be used inside of outside?
45	Do you (does the actor) take the durability of the material into consideration?
46	Do you (does the actor) take the possibility of corrosion into considering material properties or finishing?
47	Do you (does the actor) take the need for maintenance into consideration during?
48	Do you (does the actor) take the local technical skills into consideration?
49	Do you (does the actor) take the price of the product and maintenance costs into consideration?
50	Do you (does the actor) take the appearance into consideration like changing the colours or material prints?
51	Do you (does the actor) take the optimal pelvic position into consideration?
52	Do you (does the actor) take the spinal alignment into consideration?
53	Do you (does the actor) take skin integrity into consideration?
54	Do you (does the actor) take the shoulder/push rim orientation into consideration?
55	Do you (does the actor) take the axle width, seat with or chamber into consideration?
56	Do you (does the actor) take the variability in angles and length of body parts into consideration?
57	Do you (does the actor) adjust the wheelchair to outdoor conditions?
58	Do you (does the actor) try to make a durable product by considering the weight and strength of the wheelchair?
59	Do you (does the actor) take the intensity of use into consideration during the material choice?
60	Do you (does the actor) take the configuration of the wheels into consideration?
61	Do you (does the actor) take the material impact during spasm and the functionality of the brakes into consideration?
62	Do you (does the actor) take the usability of the wheelchair during use of other transport devices like car and bus into consideration?
63	Do you (does the actor) give specific attention to the seating system?
64	Do you (does the actor) take the ability to clean the wheelchair into consideration?
65	Do you (does the actor) take the availability and maintenance of bearings into consideration?
66	Do you (does the actor) take the maintainability of the folding mechanism into consideration?
67	Do you (does the actor) make a choice between massive or air tubes? into consideration?
68	Do you (does the actor) take the need for tools for adjustment into consideration?
69	Do you (does the actor) take the appearance of the wheelchair into consideration?
70	Does the consideration of the aspects above result in a usable wheelchair considering the activities and participation of the user and caregivers?
71	Do you (does the actor) arrange for or produce prototypes or devices?
81	Do you (does the actor) test the products and devices on safety, strength and durability?
82	Do you (does the actor) test if the products and devices meet the individual needs of the user?
83	Do you (does the actor) train the individual user how the wheelchair should be used and maintained?
91	Do you (does the actor) evaluate if the needs of the PwD are met by the new wheelchair within 1 month after the delivery, and if not reassesses the needs?
92	Do you (does the actor) evaluate if there are changes in the situation of the PwD within 1 month after the delivery, and if so reassesses?
93	Do you (does the actor) evaluate if the unmet needs of the PwD can be solved by the technical possibilities, within 1 month after the delivery and if so takes initiatives for improvement?
94	Do you (does the actor) tries to find information on other possibilities, if the product of the current actor can not come up with a solution, within 1 month?
95	Do you (does the actor) evaluate if the needs of the PwD are met by the new wheelchair between 1 and 6 months after the delivery and reassess the needs?
96	Do you (does the actor) evaluate if there are changes in the situation of the PwD between 1 and 6 months after the delivery and reassess the PwD situation?
97	Do you (does the actor) evaluate if the unmet needs of the PwD can be solved by the technical possibilities between one and six months after the delivery and if so takes initiatives for improvement?
98	Do you (does the actor) tries to find information on other possibilities, if the product of the current actor can not come up with a solution between one and six months after the delivery?

X. INDICATOR DETAILS AND REFERENCES

This appendix contains the more detailed information that can be collected during the assistive technology services according to the ICF classification. The data is extended with guidelines for rehabilitation assessment.

PwD Data collection, according to ICF Classification
Personal factors
name address date of birth race/tribe/religion phone personal situation goals and expectations list present problems and their treatment information on previous efforts to improve mobility age of current wheelchair way of purchase?(selected or handed down) dependency on others

Table 1. Personal factors.

PwD Data collection, according to ICF Classification		
Body Structures		
chapter	code	Anatomy of
C1	s-110-189	nerve system
C2	s-210-289	eye and ear
C3	s-310-399	structures involved in voice and speech cardio vascular, hematological, immune and respiratory system
C4	s-410-499	digestion system, metabolic and hormonal system
C5	s-510-599	urogenital system, reproductive system
C6	s-610-699	functions of the motory system
C7	s-710-799	s-710 head and neck s-720 shoulder belt s-730 upper extremity s-740 pelvic belt s-750 lower extremity s-760 middle part of he body s-770 extra related structures s-780 others
C8	s-810-899	skin and related structures

Table 2. Body structures.

PwD Data collection, according to ICF Classification		
Body Functions		
chapter	code	functions
C1	b-110-189	mental functions
C2	b-210-289	sensory functions
C3	b-310-399	voice and speech
C4	b-410-499	cardio vascular, hematological, immune and respiratory system
C5	b-510-599	digestion system, metabolic and hormonal system
C6	b-610-699	urogenital system, reproductive system
C7	b-710-799	functions of the motory system
	b-710-729	functions of the joints and bones
	b-710	mobility of joints
	b-715	stability of joints
	b-720	mobility of bones
	b-729	others
	b-730-749	functions of the muscles
	b-730	strength
	b-735	tonus
	b-740	endurability
	b-750-789	functions of the motory system
	b-750	motory reflex
	b-755	unarbitrary muscle reaction
	b-760	movement pattern
	b-765	awareness of muscle contraction
C8	b-810-899	skin and related structures

Table 3. Body Functions.

Social Data collection, according to ICF Classification		
External factors		
chapter		indicators
C1	products and technology natural environment and by humans changed	local technical skills and tools
C2	environment (geographical factors)	infrastructure road condition slopes
C3	support and relations (primary caregivers)	family friend willingness to help by strangers
C4	attitudes	
C5	services, systems and policies	local social support local technical support

Table 6. External factors (environmental factors).

Social Data collection, according to ICF Classification			
Body Measurements sheet			
chapter	code		
C1	s-110-189	nerve system	
C2	s-210-289	eye and ear	
C3	s-310-399	structures involved in voice and speech	
C4	s-410-499	cardio vascular, hematological, immune and respiratory system	
C5	s-510-599	digestion system, metabolic and hormonal system	
C6	s-610-699	urogenital system, reproductive system	
C7	s-710-799	functions of the motory system	
	b-710-729	functions of the joints and bones	functions of the motory system
		b-710 mobility of joints	s-710 head and neck
		b-715 stability of joints	s-720 shoulder belt
		b-720 mobility of bones	s-730 upper extremity pelvic
		b-729 others	s-740 belt
	b-730-749	functions of the muscles	s-750 lower extremity middle part of he
		b-730 strength	s-760 body extra related
		b-735 tonus	s-770 structures
		b-740 endurability	s-780 others
	b-750-789	functions of the motory system	
		b-750 motory reflex	
		b-755 unarbitrary muscle reaction	
		b-760 movement pattern	
		b-765 awareness of muscle contraction	
C8	s-810-899	skin and related structures	

Table 4. Body Measurements.

Social Data collection, according to ICF Classification		
Activities and participation (lifestyle and process tree)		
chapter	code	
C1	d-110-189	learning
C2	d-210-289	common task and demands
C3	d-310-399	communication
C4	d-410-499	mobility
		d-410-429 change and maintain body posture
		d-430-449 carry, lift and move objects
		d-450-469 walk and transfer
		d-470-489 transfer and transport with a device (including wheelchair)
C5	d-510-599	personal hygiene and care
		d-510 wash
		d-520 care
		d-530 toilet
		d-540 dress
		d-550 eat
		d-560 drink
		d-570 personal healthcare
C6	d-610-699	household
		acquisition of commodities
		household tasks
		care of household members
C7	d-710-799	Inter human interactions
C8	d-810-899	living environment
		education
		job and profession
		economic life
C9	d-910-999	community social and civil life
		d910 community life
		d920 recreation and spare time
		d930 religion and spirituality
		d940 human rights
		d950 politics and civil status

Table 5. Activities and participation.

Practical approach of information gathering according to Bergen

0 gather background information

Explain: Why are you visiting?

Ask:

How old are you?

Do you live alone or with others? If the respondent lives with others, ask: In what ways might they be helpful or a problem?

What is your occupation?

How far is your house from this workshop? If the distance is more than is convenient for the respondent, ask: How did you get here? Do you plan to go back today? If not, how will you manage overnight accommodation?

What disability are you looking for help with?

What caused it? How old were you when this happened?

Have you had an assistive device before? If the answer is yes, ask: When did you get it and how long did you have it? What were the good and bad aspects of wearing it? Who prescribed it for you?

What do you expect a new assistive device will be like?

What do you want to be able to do with it?

What are the goals of the user, caregiver, other actors?

Explain what you do and why you do it

talk and inform the

PwD and caregivers

Ask for permission, for touching, undressing, moving

1 Clinical assessment:

Observe the client in the current wheelchair

What need is already observed

What needs are observed as well

Ask if the client always sits this way

Ask caregivers to seat the PwD properly (training indicator)

Lift, place supports, fasten belts

Observe the interaction of equipment with the user

2 Supine Mat measurement (elimination of gravity for optimal positioning)

Check tone, alignment, available range of motion

Flex both knees (hamstring shortening

3 Seated evaluation

Use a simulator or chair

4 Simulate

Set objectives for each body part

Inhibit: Try to inhibit tone, a movement pattern or primitive reflex

Facilitate: try to facilitate a movement, a contraction in muscle groups , better control or stability of a body part.

Control: try to control alignment, stops extraneous movements or simply support the body

Accommodate: try to accommodate deformity, body protrusion, allow for limited range of movements

5 List properties of needed supporting surfaces

Table 7. Practical approach of information gathering according to Bergen.

XI CONTROL OF REPRESENTATIVENESS

In the ideal situation, the snowball method will end, because all individuals within the population are identified. In practice the number of actors identified can also be limited, by the available time and money available for the research. This should be considered, together with the representativeness of the sample and the available time and funding for the data collection methods.

While the research was in progress, more and more data was revealed about the total population of actors. The registered populations are those actors that are known by the government of Thailand. The data of the governmental registration was not up to date, nor complete. The population of PwDs and caregivers is larger than the total registered population, because registration as a PwD is not compulsory. Since 1994 PwDs can register in order to receive social and medical care. During the research, not all PwDs interviewed were registered. Similar differences were found between the registered wheelchair manufacturers and importers. New companies and importers had started and other companies stopped their business. Since no better information was available, the information found was used to control the representativeness of the sample. Considering the practical use of the research, the amount of data and the variety of actors, the information is representative for Northern Thailand, since all the providing hospitals, rehabilitation centers and wheelchairs dealers were examined. The total number of NGOs active in Thailand on the subject of PwDs is about fifty, but most of them are only active in Bangkok. In Chiang Mai all the organizations involved in wheelchair provision were examined. The number of PwDs and caregivers interviewed is small, considering the large number of estimated wheelchair needed for PwDs. The PwDs and caregivers interviewed 3 PwDs are currently living in the city of Chiang Mai and 8 are living in rural conditions. 3 PwDs were living outside Chiang Mai City, but in conditions with reasonable infrastructure and houses on floor level on an unpaved area. This reflects the 80% rate of PwDs living in rural conditions.

Classification of the population	Area of the population	sample	Total of the registered population
PwDs and caregivers and their equipment	Northern Thailand	14 PwDs / caregivers	1500 (wheelchair needed estimate)
Social Facilitators (SF)	Northern Thailand	1 FEDPD/CMDC 2 FDC (3 NCDC) (4 McKean)	50 NGOs
Medical facilitators(MF)	Northern Thailand	1 Maharaj 2 Nakornping 3 NCDC 4 Mc Kean	5 governmental hospitals 15 private hospitals of various size
Technical service facilitators(TF)		1 FWW 2 Pharma Choice 3 Pharma Store 4 Wheels of Hope 5 Wheelchair Foundation (6 Mc Kean)	6 maintenance facilitators (3 bicycle repair shops) (Numerous metal workshops and motorbike repair facilities)
Manufacturers	Thailand	1 FWW 2 Soma 3 Singha 4 Siam	8 (see Appendix XIV and XIII)
Dealer	Chiang Mai	1 Pharma Choice (6) 2 Pharma Store (2)	8 (see Appendix XIV and XIII)
Importer	Thailand	-	8 (see Appendix XIV and XIII)

Not all organizations were strongly involved in the networks in Northern Thailand or only play a minor role in the actual ATS. The wheelchairs produced by manufacturers located in Bangkok could sometimes be purchased at dealers in Chiang Mai. If the manufacturers could be visited, then this was done to be able to collect more data about the product and production technology. Some organizations take part in several categories of service, but their contribution is limited. In that case, the name is placed between brackets.

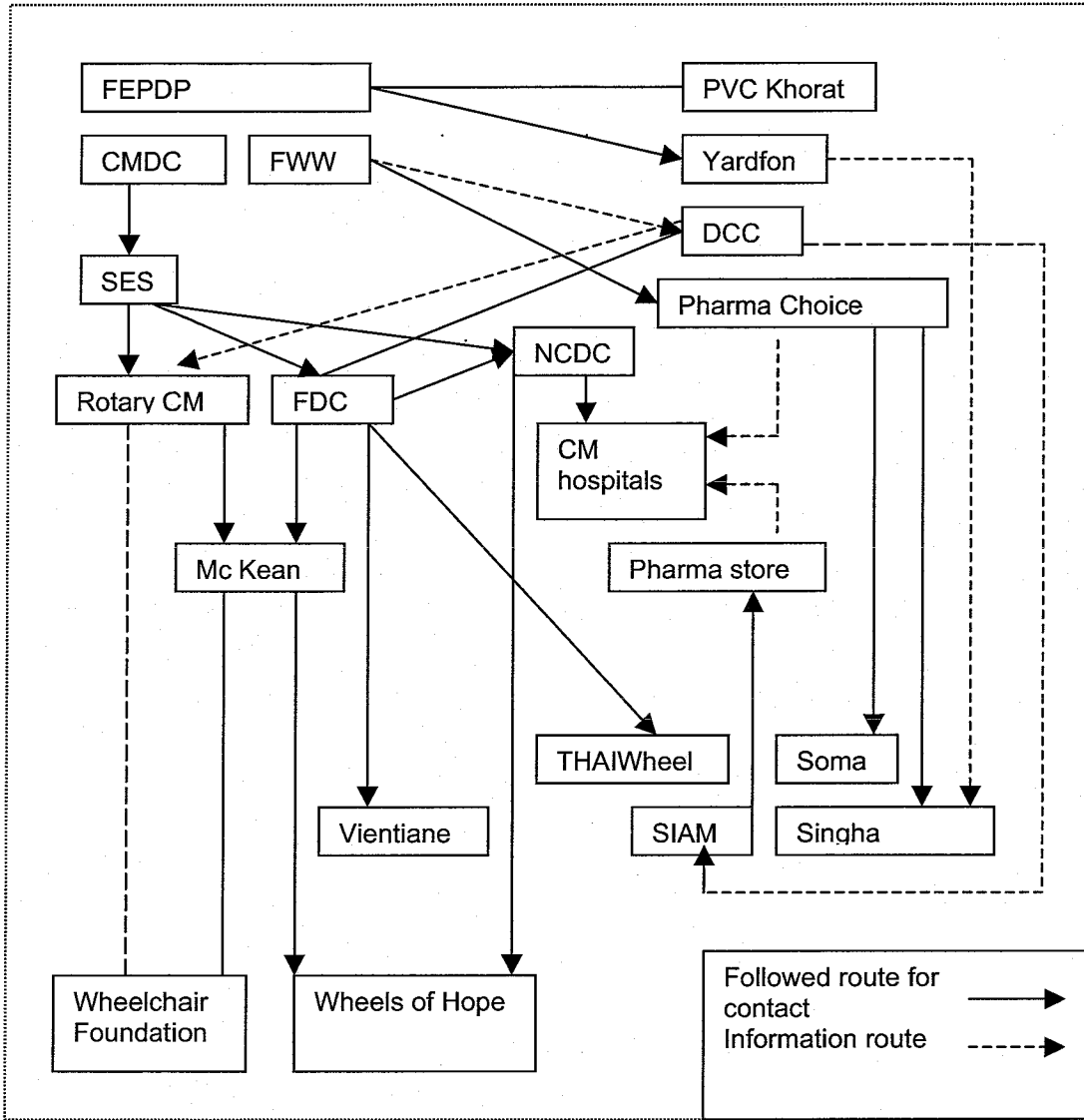


Figure V. Networks as identified by snowball sampling. The followed route for contact is the path on which the organization was identified. The information route was the route or the contacts through which contact was made for data collection.

XII IDENTIFICATION OF ACTORS AND NETWORK

The research was started on behalf of the Foundation to Encourage the Potential of Disabled People and their operating organizations, Chiang Mai Disabled Centre and Freedom Wheelchair Workshop. These organizations were located in Chiang Mai. Since this was the largest city in Northern Thailand, this location was chosen to start the snowball sampling. By talking to wheelchair users and their contacts with different interest organizations that had something to do with disabled people, the origin of their assistive technology was recovered. The people were asked, if they knew more wheelchair users, or organizations that provide assistive technology services. The persons they mention were the next subjects of research. Different contacts were made with diverse institutions that had something to do with the design, production, and allocation of assistive technology or had some kind of interest within the disabled community. This resulted in a wide variety of individuals, NGOs, Medical Facilitators, workshops and manufacturers.

The actors questioned during the snowball method gave information, about organizations, with which they have contacts. People mentioned the organizations that they worked with, but also the organizations that they did not work with. In most cases, actors could be contacted on reference of the last actor. If they did not have contact, but knew organizations, we waited, until we could contact the organization through another identified contact. Here we give a brief report of the organizations and how they were identified, as shown in figure 2.

The Foundation to Encourage the Potential Disabled Persons (FEPDP) was the host organization. The Chiang Mai Disabled Centre (CMDC) contains the offices for administration of the wheelchair sponsorship program. FWW produces, adapts and maintains mobility devices. Freedom Wheelchair Workshop (FWW) is related to CMDC, since most of the work is done for the Wheelchair Sponsorship Program of the CMDC. For equipment like crutches, the prices of buying are lower, than the price of production. These articles were bought at local pharmacy stores. Pharma Choice has six dealers in Chiang Mai, with one service point. They sold wheelchairs from Singha, Soma and imported nameless wheelchairs from Taiwan. Pharma Store had two dealers in Chiang Mai and sold Siam. The majority of assistive technology devices from the pharmacy stores were sold to elderly and ill people, on advice of a hospital or local doctor. A volunteer from VSO had contacted the Wheelchair workshop with several volunteers that were making crutches, wheelchairs and walkers from PVC water pipe. During the time of my stay, the technology of making PVC devices was transferred from Khorat to FWW. Several volunteer from Senior Expert Service (SES) had been working at the Wheelchair Workshop and Center, but during the research, the cooperation was stopped. Through volunteers from the SES we could visit the Foundation for disabled children in Thailand (FDC). This organization is involved in CBR, education and integration of PwDs in normal society. FDC has many contacts. SES and FDC have both connections with the Rotary. The rotary is involved in charity work on project basis. One of their projects was the support of the production of wheelchairs at Mc Kean. Many former local workers and visitors of the CMDC were now a member of the Disabled Campus Club (DCC). This organization was a social meeting place and organized social activities. FDC tried to cooperate with DCC for sports activities and is trying to set up social counselling. Several members of the DCC informed me on how they got their wheelchairs and how PwDs could get a wheelchair in Chiang Mai. FDC has close relations with Northern Child Development Centre (NCDC), the regional expertise centre for children with a disability. NCDC gets support for assistive devices from Wheels of Hope. A similar INGO is Wheelchair Foundation that donates wheelchairs worldwide. Several visitors of DCC had a wheelchair of the Wheelchair foundation. Besides the PwDs that came for service and repair at FWW, Individual Wheelchair users were met by the DCC and Yardfon School. Here were also PwDs found with wheelchairs from Singha and Siam, both companies which had manufacturing facilities in Bangkok. A lot of wheelchairs found were old hospital models, with a variety of origin. Besides European and American brands, several models were made in Taiwan and Japan. It was not possible to reveal their origin.

XIII INVENTORY OF ATS ACTORS

This appendix contains all the actors that have been contacted during the field research in Thailand and Laos. The first list contains only contact information. A description can be found in the main report, under the cluster description (Chapter 3.1) The other organization below have been visited, but did not play a role in the provision of wheelchairs in Thailand. Since they are so close to Northern Thailand and can play a role in future developments, they are mentioned here as well. In other parts of Thailand wheelchair manufacturers were visited. They can be found in the next appendix XIV

A. Northern Thailand

- Foundation for Disabled Children in Thailand (FDC), Masschelein Luc, Project Coordinator, 274/56 Mubaan Nantana Tambon Padat, Amphur Muang, 50100 Chiang Mai. Thailand
http://users.pandora.be/FDC_Thailand/index.html
- The Foundation to Encourage the Potential of Disabled Persons, 195/197 Ban Tanawat, Moo 8, Tambon Sanpheeseu, Amphur Muang, Chiang Mai 50300 Thailand
<http://disabled.infothai.com/index.htm>
- Maharaj Hospital, 110 Suthep Rd., T. Suthep, A. Muang, Chiang Mai 50200 Thailand
- McKean Rehabilitation Institute, P.O.Box 53 Chiang Mai 5000, Thailand
- <http://www.fpcl.org/orgs/mckean.htm>
- Northern Child Development Center. 196 Moo 4 Chiang Mai-Fang Road, Tumbon Donkaew, Amphur Mae Rim, 50180 Chiang Mai Thailand
- Nakornping Hospital, 159 Moo 4, Chotana Rd., T. Don Kaew, A. Mae Rim, Chiang Mai 50180, Thailand
- Pharma Choice, Suthep Rd., A. Muang, Chiang Mai 50200 Thailand
- Pharma Store Suthep Rd., T. Suthep, A. Muang, Chiang Mai 50200 Thailand
- The Wheelchair Foundation,
- <http://wheelchairfoundation.org>
- Wheels of Hope, Patrick Rimke, Director, 68-69, 8, Padad, Muang, Chiangmai 50000 Thailand
<http://www.wheelsofhope.org/>

B. Laos

- National Rehabilitation Center Wheelchair Workshop, Association for Aid and Relief (AAR), Laos Office. Khouvieng Rd., Sisattanak district, Vientiane, Lao PDR. P.O. Box 4045.
aarlaos@laotel.com
- Handicap International Lao PDR. 51/1 Hongkae Road, Ban Sisangvone, PO Box 2496 Vientiane. hilao@laotel.com

XIV INVENTORY OF WHEELCHAIR MANUFACTURERS AND IMPORTERS IN THAILAND

This inventory was first published by the UN and updated with the information found during the research (UN, 1997).

A. Bangkok Metropolis

- Bookalo Tricycle Shop, 34 Soi Charoennakorn 63, Charoennakorn Road, Thonburi Bangkok 106003 Produces: Tricycles.
- Chonburi Muangthong Company, Ltd. 125/26-27 Sukhumvit 55, Phrakonong, Bangkok 10110 Imports: Wheelchairs
- Golden Orient International Ltd. Part 63/5-6 Aroon- Amarint Road, Bangkoknoi Bangkok 10700 Produces: Wheelchairs, tricycles, crutches.
- Olympic Pradithakram Ltd., PART, 159/9 Soi Mooban Mahanakornnived, Vipavadeerungsit Road, Bangkokhaen, Bangkok 10220 Produces: Tricycles
- Semco Company, Ltd., 997-1001 Silom, Bangkok, Bangkok 10500 Imports: Wheelchairs
- SIAM LIMITED Ltd, Produces wheelchairs
- Singha Medical Equipment, 405/5 Rajvithee Road, Bangkok 10400 Imports: Wheelchairs.
- Thonchai Karuphan Ltd., PART., 415/20-21 Arun-amarin Road, Bangyeekun, Bangkoknoi, Bangkok 10700 Produces: Tricycles, Imports: Devices for people with visual impairments.
- UFAM Clinic Company, Ltd., 1296/69-70 Pracharaj Road, Bangsue, Bangkok 10800 Imports: Prostheses, wheelchairs, crutches/canes, devices for people with visual impairments.
- VS Engineering Company, Ltd., 282/316-8 Jarunsanitwong Road, Bangkok 10700 Imports: Wheelchairs, crutches/canes, devices for people with visual impairments.

B. Central Region

- DN Thai Willy Ltd., PART, 39/11-12 Phed hueng Road, Songkanong, Phrapadaeng, Samutprakarn, 10270 produces: Tricycles.
- Bhodeephan Supply Company, Ltd., 97/74 Moo 6, Bangkruai-Sainoi Road, Bangkruai, Nonthaburi 11130 Imports: Wheelchairs.
- Soma Medical 30 Moo 7 Tambol Khamtaleso Amphur Khamtaleso, Nakhonratchasima(KORAT) 30280 Thailand <http://www.karma.com.tw/soma/index.htm>
- THAIWHEEL- Association of the Physically Handicapped of Thailand, 73/7-8 Soi Tivanond 8,, Tivanond Road, Taladkwan, Muang, Nonthaburi 11000, Produces: Wheelchairs, tricycles, modified cars.
- Handicap International, 62/98 Moo 1, Kred-Kaew Garden 3, Soi 9, Ratanatibet Road, Nonthaburi 11000, Produces: Prostheses, wheelchairs.

C. Northern Region

- Bullard Company, Ltd., 88/8 Soi Wat Umong, Suthep Road, Amphur Muang, Chiang Mai 50200, Production ended in 2002 after the death of Mr. Bullard
- Mackean Institute for Rehabilitation, PO Box 53, Chiang Mai 50000, Produces: Prostheses, wheelchairs, Production of wheelchairs is Non-active
- Freedom Wheelchair workshop, 195/197 Ban Tanawan, Moo 8, Tambon Sanpheeseu Amphur Muang, Chiang Mai 50300 Produces Freedom wheelchairs, walkers crutches

APPENDIX XV

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	af	ag					
32	0	1	1	1	1	1	1	1	1	1	1	1	1	x	0	0	x	1	1	1	x	1	x	1	1	0	0	0	1	1	1	1	1					
33	0	1	1	1	1	1	1	1	1	1	1	1	1	x	0	0	1	x	x	1	x	0	x	1	1	0	0	1	1	1	1	1	1					
34	0	1	1	1	1	1	1	1	1	1	1	1	1	x	0	0	0	0	x	0	x	0	x	1	1	0	0	0	0	0	1	1	0					
36	0	1	1	1	1	1	1	1	1	1	1	1	1	x	0	0	1	1	x	1	x	0	x	1	1	0	0	0	1	1	1	1	1					
37	0	1	1	1	1	1	1	1	1	1	1	1	1	x	0	0	0	1	x	1	x	0	x	1	1	0	0	0	1	1	1	1	1					
38	0	1	1	1	0	1	1	1	0	1	1	1	0	x	0	0	x	x	x	x	x	0	x	x	1	1	0	0	1	1	1	1	1					
39	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	0	x	x	1	1	0	1	1	1	1	1	1					
40	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	x	0	x	1	1	0	0	0	1	1	1	1	1					
41	0	1	1	1	0	0	1	1	0	1	1	1	0	1	1	1	x	x	1	1	0	1			0	0	1	0	0	0	0	1	0	0				
42	0	1	1	1	0	1	1	1	0	1	1	1	1	0	0	1	x	x	1	1	0	1	1			0	0	0	0	0	0	0	0	0				
43	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1	x	x	1	1	1	1	1			0	0	0	0	0	0	0	0	0				
44	0	1	1	1	0	1	1	1	1	1	1	1	0	0	0	1	x	x	1	1	1	1	1			0	0	0	0	0	0	0	0	0				
45	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1	x	x	1	1	1	1	1			0	1	1	0	1	1	1	1	1				
46	0	1	1	0	0	1	1	1	1	1	1	1	1	0	0	0	x	x	x	0	0	0	1			0	1	1	0	1	1	1	1	1				
47	0	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	x	x	1	1	1	1	1			0	1	1	0	1	1	1	1	1				
48	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	x	x	1	1	1	1	0			0	1	1	0	1	1	1	1	1				
49	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1	x	x	x	1	0	1	0			0	1	1	0	1	1	1	1	0	1			
50	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	x	x	x	x	0	0	0			0	1	1	0	0	0	0	1	1	0			
51	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	x	0	1	1	0	1	1			0	0	0	0	0	0	0	0	0	0			
52	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	x	0	1	1	0	1	1			0	0	0	0	0	0	0	0	0	0			
53	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	x	0	1	1	0	1	1			0	0	0	0	1	1	1	0	0	1			
54	0	1	1	0	0	1	1	1	1	x	1	x	1	1	1	1	x	0	1	1	0	1	1			0	0	1	0	0	0	0	1	1	0			
55	0	1	1	1	0	0	1	1	1	x	0	x	1	0	1	1	x	0	1	1	0	1	1			0	0	0	0	0	0	0	0	0	0			
56	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	x	0	1	1	0	1	1			0	0	0	0	0	0	0	0	0	0			
57	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1	x	0	x	1	x	1	x			0	0	1	0	0	0	0	1	0	0			
58	0	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	x	0	1	1	0	1	1			0	0	1	0	0	0	0	1	1	0			
59	1	1	1	1	0	1	1	1	1	1	1	1	0	0	0	0	x	0	x	0	x	0	x			0	0	0	0	0	0	0	0	0	0			
60	1	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	x	0	x	0	x	0	x			0	0	1	0	0	0	0	1	0	0			
61	1	1	1	1	0	1	1	1	1	1	1	1	0	0	0	1	x	0	1	1	0	1	1			0	0	0	0	1	1	1	0	0	1			
62	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	x	0	1	1	0	1	1			0	0	1	0	1	1	1	1	1	1			
63	1	1	1	1	0	1	1	1	1	0	1	1	1	0	1	1	x	0	1	1	0	1	1			0	0	0	0	0	0	0	0	0	0	0		
64	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	x	0	1	1	0	1	1			0	0	1	0	1	1	1	1	0	1			
65	0	1	1	1	0	1	1	1	1	1	1	1	0	0	0	1	x	0	x	1	x	1	x			0	0	1	0	1	1	1	1	1	0	1		
66	0	1	1	1	0	1	1	1	1	0	1	1	0	0	0	0	x	0	x	0	x	0	x			0	0	1	0	1	1	1	1	1	0	1		
67	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	x	0	1	1	1	1	1			0	0	1	0	1	1	1	1	1	0	1		
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	x	0	x	1	x	1	x			0	0	1	0	0	0	0	1	0	0			
69	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	0	x	0	1	0	1	0	1			0	0	1	0	0	0	0	1	0	0			
70	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	x	0	1	1	1	1	1			0	0	0	0	0	0	0	0	0	0	0		
71	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	x	1	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1		
81	0	1	1	0	0	1	x	1	1	1	1	0	1	x	0	1	x	x	x	1	0	1	x			0	1	0	0	0	0	0	0	1	0	0		
82	1	0	1	1	0	1	x	1	1	1	1	0	0	0	1	1	x	x	1	1	0	1	1			0	0	0	0	0	0	0	0	0	0	0		
83	1	0	1	0	0	1	x	1	1	0	1	0	0	0	0	1	x	0	x	1	0	1	x			0	0	0	0	0	0	0	0	0	0	0	0	
91	0	0	0	0	0	0	x	0	0	0	0	0	0	0	0	0	x	0	x	0	x	x	x			0	0	0	0	0	0	0	0	0	0	0		
92	0	0	0	0	0	0	x	0	0	0	0	0	0	0	0	0	x	0	x	0	x	x	x			0	0	0	0	0	0	0	0	0	0	0	0	
93	0	0	0	0	0	0	x	0	0	0	0	0	0	0	0	0	x	0	x	0	x	x	x			0	0	0	0	0	0	0	0	0	0	0	0	
94	0	0	0	0	0	0	x	0	0	0	0	0	0	0	0	0	x	0	x	0	x	x	x			0	0	0	0	0	0	0	0	0	0	0	0	
95	1	0	1	1	0	1	x	1	1	1	1	x	1	0	1	1	x	1	1	1	0	x	1			0	0	0	0	0	0	0	0	0	0	0	0	
96	1	0	1	1	1	1	x	1	1	1	1	x	1	0	1	1	x	1	1	1	0	x	1			0	0	0	0	0	0	0	0	0	0	0	0	
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98	1	0	1	1	0	1	x	1	1	1	1	x	0	0	1	1	x	1	1	1	1	x	1			0	0	0	0	0	0	0	0	0	0	0	0	0
code	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	af	ag					

XVI DATA COLLECTION SHEETS

Cluster 1 Phase Problem	PwD data	Technical data	Responsibility Actor																																									
Ideaation	<table border="1"> <tr><td>1</td><td>1</td><td>6</td><td>1</td></tr> <tr><td>2</td><td>1</td><td>7</td><td>1</td></tr> <tr><td>3</td><td>1</td><td>8</td><td>1</td></tr> <tr><td>4</td><td>1</td><td>9</td><td>1</td></tr> <tr><td>5</td><td>1</td><td>10</td><td>1</td></tr> </table>	1	1	6	1	2	1	7	1	3	1	8	1	4	1	9	1	5	1	10	1	<table border="1"> <tr><td>21</td><td>1</td><td>26</td><td>1</td></tr> <tr><td>22</td><td>1</td><td>27</td><td>1</td></tr> <tr><td>23</td><td>1</td><td>28</td><td>1</td></tr> <tr><td>24</td><td>1</td><td>29</td><td>0</td></tr> <tr><td>25</td><td>1</td><td>30</td><td>1</td></tr> </table>	21	1	26	1	22	1	27	1	23	1	28	1	24	1	29	0	25	1	30	1	CMDC	FWW
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Evaluation	Training & testing		CDMC																																									
	Evaluation		CMDC																																									
Monitoring	Monitoring		CMDC																																									

Table 1. Data collection sheet cluster 1 according to the method.

Cluster 1 Phase Problem	PwD data	Technical data	Responsibility Actor																																										
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Table 2. Data collection sheet cluster 1 with correction of case files.

Cluster 2 Phase Problem			Responsibility Actor																																															
Ideaation	PwD data	<table border="1"> <tr><td>1</td><td>1</td><td>6</td><td>1</td></tr> <tr><td>2</td><td>1</td><td>7</td><td>1</td></tr> <tr><td>3</td><td>1</td><td>8</td><td>1</td></tr> <tr><td>4</td><td>1</td><td>9</td><td>1</td></tr> <tr><td>5</td><td>1</td><td>10</td><td>1</td></tr> </table>	1	1	6	1	2	1	7	1	3	1	8	1	4	1	9	1	5	1	10	1	<table border="1"> <tr><td>21</td><td>1</td><td>26</td><td>1</td></tr> <tr><td>22</td><td>1</td><td>27</td><td>1</td></tr> <tr><td>23</td><td>1</td><td>28</td><td>1</td></tr> <tr><td>24</td><td>1</td><td>29</td><td>1</td></tr> <tr><td>25</td><td>1</td><td>30</td><td>1</td></tr> </table>	21	1	26	1	22	1	27	1	23	1	28	1	24	1	29	1	25	1	30	1	<table border="1"> <tr><td>NCDC</td><td></td></tr> <tr><td>McKean</td><td>WH</td></tr> <tr><td>FDC</td><td></td></tr> </table>	NCDC		McKean	WH	FDC	
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Table 3. Data collection sheet cluster 2, with Wheels of Hope as donor.

Cluster 2 Phase Problem	PwD data	Technical data	Responsibility Actor																																														
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Table 4. Data collection sheet cluster 2 with the Wheelchair Foundation as donor.

Cluster 3			Responsibility Actor																																									
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Table 5. Data collection sheet cluster 3 with Pharma Store as dealer.

Cluster 3 Phase Problem	PwD data	Technical data	Responsibility Actor																																									
Problem	<table border="1"> <tr><td>1</td><td>0</td><td>6</td><td>0</td></tr> <tr><td>2</td><td>1</td><td>7</td><td>0</td></tr> <tr><td>3</td><td>1</td><td>8</td><td>1</td></tr> <tr><td>4</td><td>1</td><td>9</td><td>0</td></tr> <tr><td>5</td><td>1</td><td>10</td><td>0</td></tr> </table>	1	0	6	0	2	1	7	0	3	1	8	1	4	1	9	0	5	1	10	0	<table border="1"> <tr><td>21</td><td>1</td><td>26</td><td>x</td></tr> <tr><td>22</td><td>1</td><td>27</td><td>x</td></tr> <tr><td>23</td><td>x</td><td>28</td><td>x</td></tr> <tr><td>24</td><td>1</td><td>29</td><td>x</td></tr> <tr><td>25</td><td>x</td><td>30</td><td>1</td></tr> </table>	21	1	26	x	22	1	27	x	23	x	28	x	24	1	29	x	25	x	30	1	(CMH)	Singha
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Table 6. Data collection sheet cluster 3 with Pharma Choice as dealer.

Cluster 1	Phase	Problem	PwD data	Technical data	Responsibility Actor																																										
			<table border="1"> <tr><td>1</td><td>1</td><td>6</td><td>0</td></tr> <tr><td>2</td><td>1</td><td>7</td><td>0</td></tr> <tr><td>3</td><td>1</td><td>8</td><td>1</td></tr> <tr><td>4</td><td>1</td><td>9</td><td>1</td></tr> <tr><td>5</td><td>1</td><td>10</td><td>0</td></tr> </table>	1	1	6	0	2	1	7	0	3	1	8	1	4	1	9	1	5	1	10	0	<table border="1"> <tr><td>21</td><td>x</td><td>26</td><td>x</td></tr> <tr><td>22</td><td>x</td><td>27</td><td>x</td></tr> <tr><td>23</td><td>x</td><td>28</td><td>x</td></tr> <tr><td>24</td><td>x</td><td>29</td><td>x</td></tr> <tr><td>25</td><td>x</td><td>30</td><td>x</td></tr> </table>	21	x	26	x	22	x	27	x	23	x	28	x	24	x	29	x	25	x	30	x	<table border="1"> <tr><td>CMDC</td></tr> <tr><td>FWW</td></tr> </table>	CMDC	FWW
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Table 7. Data collection sheet cluster 1, Case of Nappasawan.

Cluster	Phase	Problem	PwD data	Technical data	Responsibility Actor																																										
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Table 8. Data collection sheet cluster 1, Case of Atipong.

Cluster 1	Phase	Problem	PwD data	Technical data	Responsibility Actor																																										
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	Production		<table border="1"> <tr><td>71</td><td>1</td></tr> </table>	71	1		<table border="1"> <tr><td>FWW</td></tr> </table>	FWW																																							
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	Evaluation		<table border="1"> <tr><td>81</td><td>0</td></tr> <tr><td>82</td><td>1</td></tr> <tr><td>83</td><td>0</td></tr> </table>	81	0	82	1	83	0		<table border="1"> <tr><td>CDMC</td></tr> </table>	CDMC																																			
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Table 9. Data collection sheet cluster 1, Case of Tanyarak.

Cluster 1 Phase Problem		Responsibility Actor																																																			
Ideation	<table border="1"> <tr><th colspan="4">PwD data</th></tr> <tr><td>1</td><td>1</td><td>6</td><td>1</td></tr> <tr><td>2</td><td>1</td><td>7</td><td>1</td></tr> <tr><td>3</td><td>1</td><td>8</td><td>1</td></tr> <tr><td>4</td><td>1</td><td>9</td><td>1</td></tr> <tr><td>5</td><td>1</td><td>10</td><td>1</td></tr> </table>	PwD data				1	1	6	1	2	1	7	1	3	1	8	1	4	1	9	1	5	1	10	1	<table border="1"> <tr><th colspan="4">Technical data</th></tr> <tr><td>21</td><td>1</td><td>26</td><td>1</td></tr> <tr><td>22</td><td>1</td><td>27</td><td>1</td></tr> <tr><td>23</td><td>1</td><td>28</td><td>1</td></tr> <tr><td>24</td><td>1</td><td>29</td><td>0</td></tr> <tr><td>25</td><td>1</td><td>30</td><td>1</td></tr> </table>	Technical data				21	1	26	1	22	1	27	1	23	1	28	1	24	1	29	0	25	1	30	1	<table border="1"> <tr><td>CMDC</td><td>FWW</td></tr> </table>	CMDC	FWW
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Table 10. Data collection sheet cluster 1, Case of the Twin.

Cluster 1				Responsibility Actor																																										
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Problem	PwD data	Technical data																																												
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Table 11. Data collection sheet cluster 1, Case of Seowan.

Cluster Phase			Responsibility Actor																																											
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	Evaluation	Matching & selection	<table border="1"> <tr><td>51</td><td>0</td><td>56</td><td>1</td><td>61</td><td>1</td><td>66</td><td>1</td></tr> <tr><td>52</td><td>0</td><td>57</td><td>1</td><td>62</td><td>0</td><td>67</td><td>0</td></tr> <tr><td>53</td><td>1</td><td>58</td><td>1</td><td>63</td><td>1</td><td>68</td><td>0</td></tr> <tr><td>54</td><td>1</td><td>59</td><td>1</td><td>64</td><td>0</td><td>69</td><td>1</td></tr> <tr><td>55</td><td>1</td><td>60</td><td>1</td><td>65</td><td>1</td><td>70</td><td>0</td></tr> </table>	51	0	56	1	61	1	66	1	52	0	57	1	62	0	67	0	53	1	58	1	63	1	68	0	54	1	59	1	64	0	69	1	55	1	60	1	65	1	70	0			FWW CMDC
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Table 12. Data collection sheet cluster 1, Case of Nattapat

Cluster	Phase	Problem	PwD data	Technical data	Responsibility Actor																																										
			<table border="1"> <tr><td>1</td><td>1</td><td>6</td><td>0</td></tr> <tr><td>2</td><td>0</td><td>7</td><td>1</td></tr> <tr><td>3</td><td>1</td><td>8</td><td>1</td></tr> <tr><td>4</td><td>1</td><td>9</td><td>0</td></tr> <tr><td>5</td><td>0</td><td>10</td><td>1</td></tr> </table>	1	1	6	0	2	0	7	1	3	1	8	1	4	1	9	0	5	0	10	1	<table border="1"> <tr><td>21</td><td>1</td><td>26</td><td>1</td></tr> <tr><td>22</td><td>1</td><td>27</td><td>1</td></tr> <tr><td>23</td><td>1</td><td>28</td><td>1</td></tr> <tr><td>24</td><td>1</td><td>29</td><td>0</td></tr> <tr><td>25</td><td>1</td><td>30</td><td>1</td></tr> </table>	21	1	26	1	22	1	27	1	23	1	28	1	24	1	29	0	25	1	30	1	<table border="1"> <tr><td>CMDC</td></tr> </table> <table border="1"> <tr><td>FWW</td></tr> </table>	CMDC	FWW
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	Production	Production	<table border="1"> <tr><td>71</td><td>1</td></tr> </table>	71	1		<table border="1"> <tr><td>FWW</td></tr> </table>	FWW																																							
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	Evaluation	Training & testing	<table border="1"> <tr><td>81</td><td>1</td></tr> <tr><td>82</td><td>1</td></tr> <tr><td>83</td><td>0</td></tr> </table>	81	1	82	1	83	0		<table border="1"> <tr><td>CDMC</td></tr> </table>	CDMC																																			
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Table 13. Data collection sheet cluster 1, Case of Waruni.

Cluster 1 Phase Problem	PwD data	Technical data	Responsibility Actor																																										
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Table 14. Data collection sheet cluster 1, Case of Somchai.

Cluster 1 Phase Problem	PwD data	Technical data	Responsibility Actor																																										
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Table 15. Data collection sheet cluster 1, Case of Sanguay.

Cluster 1 Phase Problem	PwD data	Technical data	Responsibility Actor																																										
	<table border="1"> <tr><td>1</td><td>1</td><td>6</td><td>1</td></tr> <tr><td>2</td><td>1</td><td>7</td><td>1</td></tr> <tr><td>3</td><td>1</td><td>8</td><td>1</td></tr> <tr><td>4</td><td>1</td><td>9</td><td>1</td></tr> <tr><td>5</td><td>1</td><td>10</td><td>1</td></tr> </table>	1	1	6	1	2	1	7	1	3	1	8	1	4	1	9	1	5	1	10	1	<table border="1"> <tr><td>21</td><td>1</td><td>26</td><td>1</td></tr> <tr><td>22</td><td>1</td><td>27</td><td>1</td></tr> <tr><td>23</td><td>1</td><td>28</td><td>1</td></tr> <tr><td>24</td><td>1</td><td>29</td><td>0</td></tr> <tr><td>25</td><td>1</td><td>30</td><td>1</td></tr> </table>	21	1	26	1	22	1	27	1	23	1	28	1	24	1	29	0	25	1	30	1	<table border="1"> <tr><td>CMDC</td></tr> <tr><td>FWW</td></tr> </table>	CMDC	FWW
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Table 16. Data collection sheet cluster 1, Case of Banitaa.

Cluster 2 Phase Problem			Responsibility Actor																																															
Ideaation	PwD data	<table border="1"> <tr><td>1</td><td>0</td><td>6</td><td>0</td></tr> <tr><td>2</td><td>0</td><td>7</td><td>0</td></tr> <tr><td>3</td><td>0</td><td>8</td><td>0</td></tr> <tr><td>4</td><td>0</td><td>9</td><td>0</td></tr> <tr><td>5</td><td>0</td><td>10</td><td>0</td></tr> </table>	1	0	6	0	2	0	7	0	3	0	8	0	4	0	9	0	5	0	10	0	<table border="1"> <tr><td>21</td><td>x</td><td>26</td><td>x</td></tr> <tr><td>22</td><td>x</td><td>27</td><td>x</td></tr> <tr><td>23</td><td>1</td><td>28</td><td>x</td></tr> <tr><td>24</td><td>1</td><td>29</td><td>x</td></tr> <tr><td>25</td><td>x</td><td>30</td><td>x</td></tr> </table>	21	x	26	x	22	x	27	x	23	1	28	x	24	1	29	x	25	x	30	x	<table border="1"> <tr><td>NCDC</td><td>WF</td></tr> <tr><td>McKean</td><td></td></tr> <tr><td>FDC</td><td></td></tr> </table>	NCDC	WF	McKean		FDC	
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	Production	<table border="1"> <tr><td>71</td><td>0</td></tr> </table>	71	0	<table border="1"> <tr><td>WF</td></tr> </table>	WF																																												
71	0																																																	
WF																																																		
	Training & testing	<table border="1"> <tr><td>81</td><td>0</td></tr> <tr><td>82</td><td>0</td></tr> <tr><td>83</td><td>0</td></tr> </table>	81	0	82	0	83	0	<table border="1"> <tr><td>NCDC</td><td></td></tr> <tr><td>McKean</td><td></td></tr> <tr><td>FDC</td><td></td></tr> </table>	NCDC		McKean		FDC																																				
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McKean																																																		
FDC																																																		

Table 17. Data collection sheet cluster 2, Case of Nong Nu 's ATI Hotchkiss.

Cluster 2 Phase Problem			Responsibility Actor				
Problem	PwD data		<table border="1"> <tr><td>NCDC</td><td rowspan="10">WF</td></tr> <tr><td>McKean</td></tr> <tr><td>FDC</td></tr> </table>	NCDC	WF	McKean	FDC
	NCDC	WF					
	McKean						
	FDC						
	1			0 6 0		21 x 26 x	
	2			0 7 0		22 x 27 x	
	3			0 8 0		23 1 28 x	
	4			0 9 0		24 1 29 x	
	5			0 10 0		25 x 30 x	
	PwD needs			Technological possibilities			
11	0 16 0		31 x 36 x				
12	0 17 0	32 x 37 x					
13	0 18 0	33 x 38 x					
14	0 19 0	34 x 39 x					
15	0 20 0	35 x 40 x					
Ideation	Idea & concept generation		<table border="1"> <tr><td>NCDC</td></tr> <tr><td>McKean</td></tr> <tr><td>FDC</td></tr> </table>	NCDC	McKean	FDC	
	NCDC						
	McKean						
	FDC						
	41	0 46 0					
	42	0 47 0					
	43	0 48 0					
	44	0 49 0					
	45	0 50 0					
	Matching & selection			<table border="1"> <tr><td>NCDC</td></tr> <tr><td>McKean</td></tr> <tr><td>FDC</td></tr> </table>	NCDC	McKean	FDC
NCDC							
McKean							
FDC							
51	0 56 0 61 0 66 0						
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53	0 58 0 63 0 68 0						
54	0 59 x 64 0 69 0						
55	1 60 x 65 0 70 0						
Production	Production		<table border="1"> <tr><td>WF</td></tr> </table>	WF			
	WF						
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Evaluation	Training & testing		<table border="1"> <tr><td>NCDC</td></tr> <tr><td>McKean</td></tr> <tr><td>FDC</td></tr> </table>	NCDC	McKean	FDC	
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Evaluation		<table border="1"> <tr><td>NCDC</td></tr> <tr><td>McKean</td></tr> <tr><td>FDC</td></tr> </table>	NCDC	McKean	FDC		
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	McKean						
	FDC						
	95	0					
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Table 18. Data collection sheet cluster 2, Case of Kuhn Boon WF wheelchair

Cluster 3 Phase Problem	PwD data	Technical data	Responsibility Actor																																												
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Table 19. Data collection sheet cluster 3, Case of Chomvit

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Table 20. Data collection sheet cluster 3, Case of William



Figure a. Nappasawan 's grandfather covered some end tubes to prevent damage and corrosion.



Figure b. Atipong in her oversized hospital wheelchair.



Figure c. During the assessment of Atipong, she appeared to have the ability to walk with guidance.

XVII INDIVIDUAL CASES

This appendix describes the individual cases of the PwDs that were interviewed and observed during the field research in Northern Thailand. After an introduction of the PwD, the aspects of the activities are discussed. The numbers in-between brackets refer to the indicators and code of the questions of the research instrument. Aspects that were not a part of the research instrument, or not described in detail, but did have a great influence on the wheelchair provision are explained as well.

XVII. I Cluster 1

The research data from the first four individual cases was collected by study of the client files and observation, interaction and interviewing the PwD and caregivers. The last 6 cases were examined, using the client files and observation during the production or adaptation and maintenance at the wheelchair workshop. After the introduction of the client, the wheelchair provision is briefly explained for a better understanding of the research data sheet.

Nappasawan - 3 wheel wheelchair

Nappasawan is very bright CP child. She should go to school, but the local school is not accessible with a wheelchair. In the beginning the grandparents did not show much interest in education. She visited a special education center several times, but it is not possible for the grandparents to bring her to school. She received a 3 wheel wheelchair and later a standing table. She continues to progress and with physiotherapy, she will be able to learn how to walk.

During the visits became clear that the position in the wheelchair was very good, but she could not propel the chair, because the frame and wheel sizes were not optimal (54, 60). The wheelchair fitted correctly but was not maintained. The paint came off quite easy and corrosion was visible (46). During the first visit, the wheelchair needed new inner tubes. The parents could not buy them in the area. This indicated that there was no local support (47) and that the maintenance interval is too long (48). This was repaired on the second visit, one month later. 3 months later a standing table was delivered. The wheelchair was serviced as well, but was still in good technical condition.

The grandfather had covered some end tubes, because the original end caps were gone. These observations led to changes in the model, so end caps were no longer necessary.

Atipong – classic wheelchair

Atipong was a cheerful young lady and her picture of her, sitting in a wheelchair, was used in the brochure. It was a classic hospital model and was much too wide. She did not use the wheelchair because she would move around the house on her hands knees or buttocks. She seemed to be cheerful every time we visited. The volunteer physiotherapist examined her and was surprised about her strength and told me she had the ability to learn to walk. With regular therapy to lengthen and strengthen her muscles, and braces, she could learn how to walk. The father was shown how he could practice with her daughter and the physiotherapist tried to convince the father to visit a hospital in Chiang Mai to get her some braces measured.

Nobody paid attention to the donated wheelchair. The wheelchair was never used and stored in a bedroom. No effort was made to ask why they never used the wheelchair. Maybe the wheelchairs should not have been donated in the first place. CMDC assumed that she needed a wheelchair, so she could go out of the house, but she was not stimulated to do that. The parents never took her out with the wheelchair; what was for CMDC a reason for not providing a more appropriate model. If she was able to receive physiotherapy, she would be able to walk. Nevertheless, the wheelchair was not fitted correctly and was not suitable for the PwD (2, 3, 4, 6, 11, 12, and 15). The wheelchair was donated without considering the needs of the PwD. The problem phase was not executed correctly and during home-visits was only given attention to the PwD.



Figure d . Tanyarak with her grandparents. With special shoes and braces, she can walk. Now they use the wheelchair to go to school.

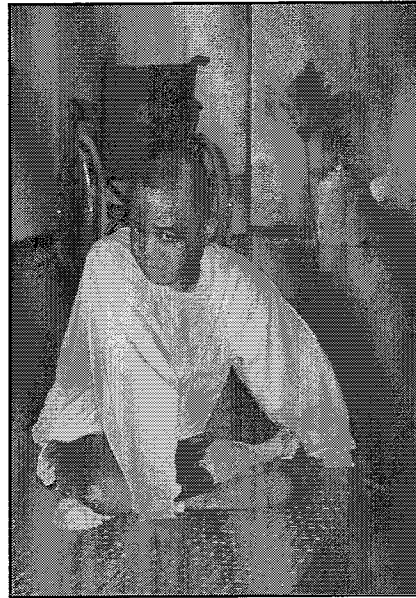


Figure e. One of the twins



Figure f. Seowan was given a 3 wheel wheelchair with extra side support and protection of tubes, to prevent damage during spasm.

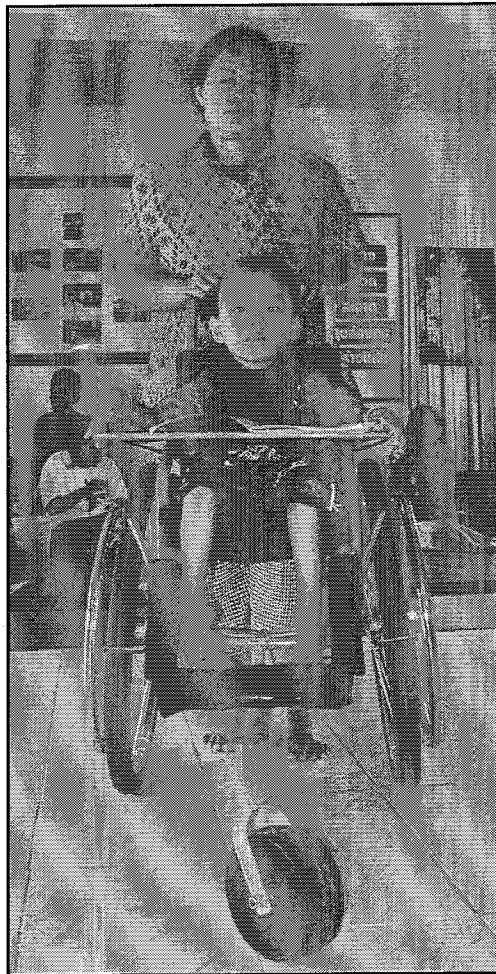


Figure g. Nattapat's feet don't get support from the footrests. This can cause damage to the heels. The harness stabilises the body but limits the freedom of movement.

Tanyarak - 3 wheel wheelchair

Tanyarak was born with spina bifida and was operated directly after birth. Her medical assessment was not complete (2). At the times of visit she could stand up and walk along the walls of the house. She had a 3-wheeled wheelchair and used it to go to school. The school was a 3 minutes walk. The grandfather adapted the footrests of the wheelchair because she would slide on the cushion (41, 51). This caused a tilt of the pelvic. The wooden plates prevented the sliding, but caused the footrests to be too high. The wheelchair needed major maintenance and the cushions had to be changed to fit her body. The axle needed to be placed further to the back, so she could propel the wheelchair by herself (55).

She had also walker, but it was not safe to use it around the house. The roads around the house were unpaved. She had specially made shoes, but she had grown out of it. The grandparents took care of her and had not taken the initiative to go to the hospital for new shoes. With physical therapy and new shoes or braces she could learn to walk.

Overall the wheelchair was provided correctly in the given circumstances. The wheelchair did not cause any trouble, because it was only used to go to school. Reference to the hospital for new shoes was done correctly, because the child could learn how to walk.

The twin Annan and Thawin - two 3 wheel wheelchairs, and...

During my volunteership at the workshop, I followed the production of 2 wheelchairs. When the wheelchair was finished, I saw a difference in axle fixation. On one wheelchair the rear axle was 10 cm further to the back. This made it much more difficult to propel the wheelchair. It was impossible to make a wheelie with it. In contrast to the drawings, the axles were not made adjustable. I was told that the adjustable axles were not produced anymore, because the users would not adjust it anyway. In only one of the chairs the measurements were adapted to the measurements of the PwD (71). Changing the thickness of the cushions solved this problem.

The deliver of the wheelchairs was 4 months after the measurements were taken. In that period, the twins had both received a wheelchair from the Wheelchair Foundation. CMDC wanted to leave as soon as possible. (The late delivery probably meant a loose of face for the organization) The wheelchairs donated by the Wheelchair Foundation had the correct measurements, but no belts for the necessary fixation. The wheelchairs were not used, because the plastic was still on the front wheels. Their usability seems limited, since the house was very small and the area around the house was uneven and unpaved. Considering the situation, it was not possible to try, which wheelchairs were the best. Process of production was done fairly well. Information on contact with other organizations was not done. Contact with other organizations could have prevented the double provision. The time to produce the wheelchairs took too long. The donated wheelchairs from the Wheelchair Foundation seemed less suitable than the models of the FWW, but it was considered inappropriate to test that.

Seowan - 3 wheel wheelchair, mature model

CMDC got in contact with Seowan after a request made by Sister Angela from the catholic mission. Seowan lived in a rural area in Lampang. She was disabled from birth, but could communicate very well.

She was visited by CMDC and the assessment was done according to the working method. On the day of delivery it was difficult to judge, if the wheelchair was comfortable for her. Because of the excitement, she could not relax. The measurements of the wheelchair were according to the measurements of her body. Later contact with Sister Angela confirmed that the wheelchair was O.K. for her. Seowan received a wheelchair according to the

Nattapat - 3 wheel wheelchair children's model

Nattapat is a bright and clever 4-year-old boy, but small for age. He's unable to walk, but can sit up with little assistance. He can use his arms, but does not seem strong. Diagnosis seems to be Muscular



Figure h. Sanguay in a refurbished wheelchair.

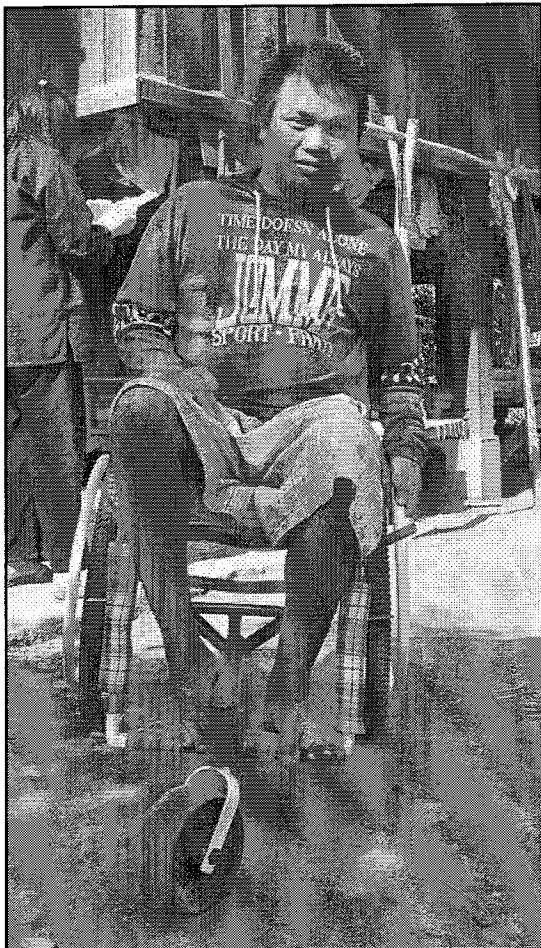


Figure i. Waruni is happy with the low floor trolley



Figure j. (above) Banitaa in her CP buggy with her concerned mother.

Figure k. (Left) Somchai in his 3-wheel wheelchair.

Dystrophy and that he will never be able to walk. He received a wheelchair 4 months after the measurements were taken.

Nattapat was not measured at home, but at Lamphun Special Education Center. Therefore there was only limited information available (2,3,5,6,7). The possibilities of local support were not known (18) The footrests were not adjusted because the adjustability was not sufficient (41, 42). Therefore they did not provide the needed support. Other measurements of the chair were correct.

Waruni - Low floor model (trolley)

Waruni has limited control over her arms or hands but is very capable with her feet. She can open a cool bucket and use a ladle to drink. Little is known about her medical situation. She has never received physical therapy or an education. She used to move around in the house on her buttocks. An ordinary wheelchair would only make her more disabled. By building a low floor model, she can move around more easily in and around the house.

The needs in and around the house are met by the low model, but the long term needs and social participation or education were not examined.(5,15) In stead she was given some drawing material to make cards, so she could earn some money.

Somchai - 3 wheel wheelchair, mature model

Somchai had a motorcycle accident in 1999. His family are very poor hill tribe farmers. The environment around the house was very uneven and unpaved. The exact disability of Somchai was not in the file, but from the description of the needs it looks like a paraplegic with paresis of the left arm.

Somchai has problems with his left arm and this makes self-propulsion difficult (14) He should be able to adapt and learn with perseverance, but a fixed rear axle would make it more easily to propel with one arm. Somchai will need a lot of practice to be able to use his wheelchair in uneven terrain. The family was asked to try to make surface more accessible. The wheelchair was made according to the measurements and fitted correctly. The wheelchair itself is suitable for the environment, but due to the problems with the PwDs hand, he can not move the wheelchair by himself. (55) This case makes it obvious that training is needed.

Sanguay - Standard refurbished wheelchair

50-year-old Sanguay had a stroke in 1998. She's paralyzed down the right side of body. She lives with her husband and daughter. The measurements of her body were similar to the basic measurements of the donated chair. There was chosen to provide a standard model, because the infrastructure around the house is fairly well. The chair fits, except for the footrests. Because the thickness of the cushion was not taken into account, the footrests are too low. These are not adjustable. She was not shown how to use the wheelchair and the heel straps should be behind the legs, and not in front of the legs. She can move around in the wheelchair, although she still paresis of the arms and the rear axle is placed relatively far to the back (54, 55, 14).

Banitaa - CP-special buggy

Banitaa came to Mae Hon Son disabled day with her mother in her CP buggy. Although the mother reported that the buggy was well maintained and used all the time, both in and out of the house, it became clear that she was afraid the buggy would tip over on the narrow hilly roads. Bantitaa very obviously liked riding in it and was all smiles. The seating system was comfortable and the adjustable angel of the seat stimulated the body. A disadvantage of the high position of the child is the limitation of other children to make contact with the child. The body part mobility is restricted by the harness, the table and toy-bar (41). The carriage of the buggy is too big to use it inside a regular house (44). That restricts the use of the seating. The used harness to fix the body does not guarantee an optima pelvic position and spinal alignment. It would be better to replace the harness with a pelvic belt and a thorax belt (51, 52). To be able to determine the correct position of these belts, the child must be placed in the seat, because the positioning of these belts has to be done with precision. Due to the high point of gravity and the low stiffness of the frame, the buggy did not give a safe feeling to the mother.

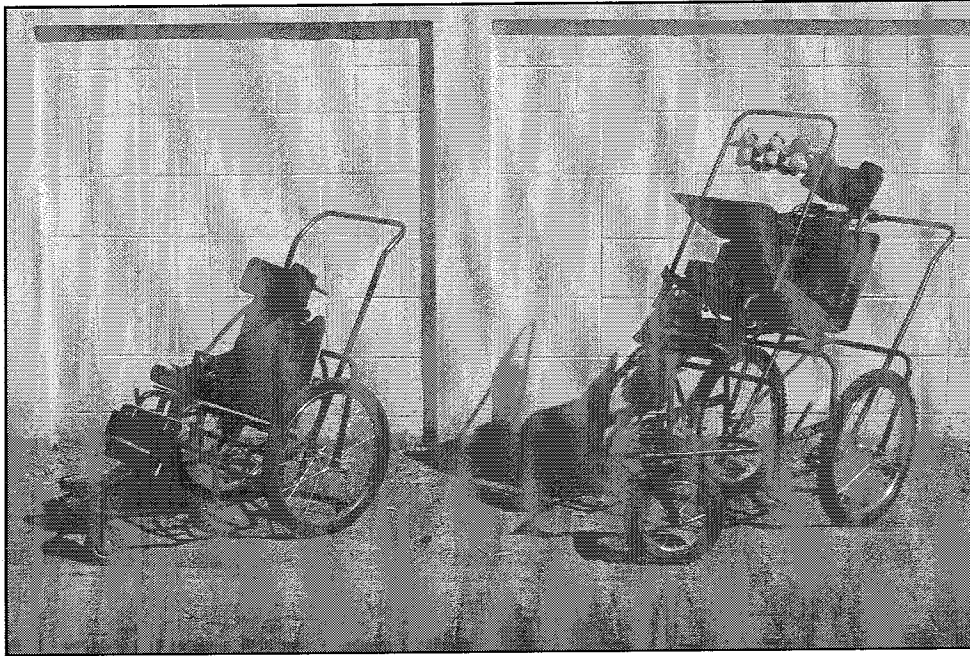


Figure l. CP buggies. The original wheelchair buggy had a high point of gravity and a frame with low stiffness. This gave the caregivers an unsafe feeling. By lowering the seat and changing the rotating point of the chair, the buggy became much more stable. The user can touch the wheels of the low buggy.



Figure m. Nong-Nu in her Invacare 9000 Wheelchair during Basketball training at NCDC.

The buggy does not give a durable impression and the fixation of (58, 59). FWW was not convinced of that. They believed the mother was over concerned. After more complaints came in (and Thai people do not complain very much, because it is considered impolite) an early model was adapted (Anghanar). After a drastic change of the model, FWW saw the benefit and the mother was happy with the changes. The standard model was lowered 20 centimetre, which gave it more resemblance to the children's model of the 3 wheel wheelchair.

XVII.II Cluster 2

In the first 2 cases research data was collected by interviewing the PwD and observing their wheelchair use. First the case of Nong –Nu is explained. It is a typical case for the way large donor organizations sometimes provide wheelchairs. The second case was a better match between PwD and Wheelchair. A third case was already mentioned in cluster 1- the twins.

Nong Nu – Invacare, ATI Hotchkiss and Quicky Sports

Nong Nu is a sportive young lady. She's lives at the Disabled Campus club and will start a training course in web design in Bangkok this year. She has a double leg amputee since birth, caused by domestic violence. She is used to lay forward on her belly. In that position, she has her arms forward and has a good mobility of her arms. She has 3 wheelchairs, of which 2 are usable. She has an Invacare 9000 XT and used in about 5 years. It was donated by an INGO. The chair had massive tires and reinforced plastic wheels. The wheelchair had a specially made cushion. Her position in the wheelchair was questionable, but it would need medical skills to judge that.

In 2002 she received another wheelchair. The members of the DCC were all invited to come to a wheelchair donation event. The majority of wheelchairs donated were two models: the wheelchair of the Wheelchair Foundation and the children's model of ATI-Hotchkiss. Although the workshop of Mc Kean did have the technological possibility to make the wheelchairs suitable for the person, the individual measurements were ignored (31-40) The ATI-Hotchkiss models were built in a workshop of McKean. It was a project of 80 wheelchairs, with support of the Rotary Club Chiang Mai. One by one the invited guests could come forward and a doctor would select a model. Nong Nu wanted to have a WF-wheelchair, because it had massive tires. It looked much nicer and with a similar adaptation to the seat, she would have a comfortable high position that made it able for her to sit at regular table height. The doctor decided that an ATI –Hotchkiss model was better for her, because she could propel that model without adaptations. Personal needs and wished of Nong Nu were not considered. Although McKean and NCDRC has the specialist to perform a proper needs inventory, there was only looked briefly at the measurements of the chair (1-20). Nong Nu kept using her Invacare model and only used the ATI-wheelchair if her Invacare model was broken and she used it when she took a shower. She disliked the ATI wheelchair, because the ATB air-tires were hard to propel and she could not pump up the tires by herself. The balance of the wheelchair was incorrect, because her point of gravity was very close to the rear axle, the wheelchair had tipped over a few times. She felt uncomfortable using it and did not like to take it outside.

With help of FDC she recently received another wheelchair. A volunteer of FDC has built her a custom wheelchair, based on a second-hand frame of a Quicky Sport. The wheels of the Invacare were taken and new caster forks were made. The wheels were put on a 4° angle⁶, and the front wheels were 10 mm sports wheels, available at the local Homepro hardware store. Since she started to play basketball, she can handle the chair very well. She does not experience the small wheels as a disadvantage, because the chair is so light that she can easily make a wheelie with it.

⁶ The angle of the wheels of professional sports wheelchairs can be up to 12°, for a more stable wider wheelbase and an better alignment of the pushrims and the shoulders. For daily use wide angle makes a wheelchair too wide, which makes it impossible to go through bathroom and elevator door. A 4° angle is compromise.

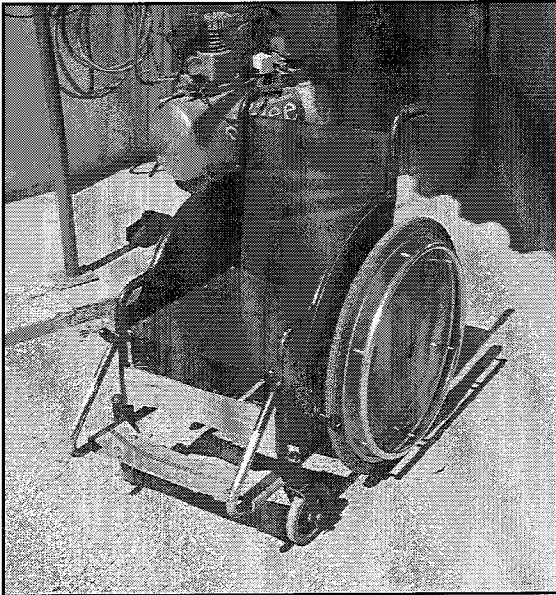


Figure n. Singha sports model of Chomvit, after the renewal of the seat and backrest.

Boon- model Wheelchair Foundation

Boon was invited to the donation ceremony as well. He received a wheelchair of the Wheelchair Foundation. The wheelchair did fit, although the footrests needed to be adjusted properly. The wheelchair was manoeuvrable in the urban area and needed little maintenance. Only the front wheels were air tubes. They could be filled at the local bicycle shop. For him the chair was a major improvement, since his old wheelchair was a worn out classic hospital model. He uses his wheelchair all day and plays basketball with it as well. He really likes the removable armrests. Without the armrest, the wheelchair is easier to propel.

XVII.III Cluster 3

Research data was collected by interviewing the PwD and observing the wheelchair use. In the first case the PwD had bought a wheelchair and knew what kind of model he wanted to have. In the second case, the wheelchair was bought without any assessment and the user learned to handle his wheelchairs, without questioning.

Cluster 3-2- Singha sports - Chomvit

In 1998 Chomvit had a spinal cord injury, caused by a motorcycle accident. He can not move his legs and needs a wheelchair the whole day. He uses the wheelchair very intensive, since he likes to play basketball. He is 20 years old and goes to Yardfon School to study electronics. The chair is 2 years old and the seat was torn and on one side the bearings of the caster wheel were worn out. He came to FWW, because Mongkohl (manager of FWW) had offered him help.

He was able to buy a Singha sports model with help from his father and a friend. They bought the wheelchair in Bangkok. They bought this model, because it was very light and was specially made for sport purposes. At that time, it was the only company that sold sports chairs in Thailand. The chair was selected after taking his measurements. He did not know if he could go to a Singha dealer for service. If something broke down. Normally he would try to find someone in his neighbourhood, who could help him. He already changed the foot support, because the material was torn before.

He liked the chair because it was a real Thai chair, and not a European model. He made several alterations by himself. He used plastics board sheets to close the wheels. That was safer during basketball and looked much nicer. He had painted the frame black, because he did not like the standard grey colour. Although he came for service, because the chair was broken, there were no things he disliked about the chair. Sometimes he got spasms and skin problems. He blamed himself for that, because he could prevent that, if he repositioned himself more regularly. He was not aware that those problems could be prevented with a good cushion and an proper adjusted fixed footplates. Singha delivered a good wheelchair and paid attention to the needs of the PwD. Chomvit is satisfied with the model. The customer is not aware of the guarantee and service possibilities of the company and prefers to maintain and repair the chair in his own environment.

The type of ankle support is only comfortable during sports, but not for long-term use, because they do not provide sufficient support. This causes spasm in the legs. The Singha dealer can not be blamed for this problem, because he never visits for service. Singha could pay more attention to seating material, to prevent skin problems.

Cluster 3-2- SIAM classic - William

William came to the workshop, with a friend. He got a spinal cord injury during the Vietnam War. Since he married a Thai, he stayed in Thailand. His friend brought his wheelchair to the workshop, because the front wheels left black marks on the wooden hotel floor. Later he came several times to drink coffee.

The SIAM chair was almost 20 years old. The wheelchair was bought at a dealer in Chiang Mai, without any assessment or conversation. He lived in a small rural village and could not go outside with his wheelchairs. If he wanted to go outside, he moved around without the chair. William liked the chair, because he never tried another one. The chair was much too wide for him and the upright sitting position was causing backaches. He assumed that was because he was getting old. He had removed the arm supports, so it was easier to push the chair. Through the years the bearings and caster wheels were worn out.

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Glossary

For a better understanding of the theoretical framework, all terms are defined. If possible, definitions were taken from international respected organizations, directly involved in the well being of the PwDs or the legal documents that were a result of the scientific research or legal documents.

Activity

The execution of a task or action by an individual (WHO, 2001)

Assistive technology

Any item, piece of equipment, or product system whether acquired commercially off the shelf, modified, or customized that is used to increase, maintain, or improve functional capabilities of individuals with disabilities. (U.S. Public Law 100-407, the Technology-Related Assistance to Individuals with Disabilities Act of 1988)

Assistive Technology Device

Any item, piece of equipment, or product system, whether acquired commercially, modified, or customized that is used to increase, maintain, or improve functional capabilities of individuals with disabilities. (IDEA, 1990)

Assistive Technology Service

Any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device. Such term includes--

(A) the evaluation of the assistive technology needs of an individual with a disability, including a functional evaluation of the impact of the provision of appropriate assistive technology and appropriate services to the individual in the customary environment of the individual;

(B) services consisting of purchasing, leasing, or otherwise providing for the acquisition of assistive technology devices by individuals with disabilities;

(C) services consisting of selecting, designing, fitting, customizing, adapting, applying, maintaining, repairing, or replacing assistive technology devices;

(D) coordination and use of necessary therapies, interventions, or services with assistive technology devices, such as therapies, interventions, or services associated with education and rehabilitation plans and programs;

(E) training or technical assistance for an individual with disabilities, or, where appropriate, the family members, guardians, advocates, or authorized representatives of such an individual; and

(F) training or technical assistance for professionals (including individuals providing education and rehabilitation services), employers, or other individuals who provide services to, employ, or are otherwise substantially involved in the major life functions of individuals with disabilities. (Individuals with a disability act, IDEA 1990, PL 101-476)

Body functioning

The physiological functions of body systems, including the psychological functions (WHO, 2001)

Body Structures

Anatomical parts of the body such as organs, limbs and their components (WHO, 2001)

Cerebral Palsy

A group of disorders associated with developmental brain injuries that occur during foetal development, birth, or shortly after birth. It is characterized by a disruption of motor skills, with symptoms such as spasticity, paralysis, or seizures. Cerebral palsy is also known as static encephalopathy. It is no longer considered a disease, but rather it is a chronic non-progressive neurological disorder. The incidence is about 1.5 to 4 per 1000 live births. There is no cure, but therapy may be helpful. It has one of the highest lifetime costs of any birth defect

Disability

Any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being. (WHO, 1980)

Environmental factors

Those factors that make up the physical societal and attitudinal environment (WHO, 2001)

Handicap

A disadvantage for a given individual, resulting from an impairment or disability that, limits or prevents the fulfilment of a role that is normal, depending on age, sex, social and cultural factors, for that individual." (WHO, 1980)

Healthcare education

The provision of information on the preservation of mental and physical health by preventing or treating illness through services offered by the health profession.

Impairment

Any loss or abnormality of psychological, physiological, or anatomical structure or function. (WHO, 1980)

Medical facilitator

Actor that makes progress to provide medical assistance, including, medical treatment, medication, surgery, therapy and assessment for seating and wheeled mobility systems.

Mobility

the quality of moving freely), to be able to participate in daily life. (Webster's dictionary, 2004)

Paraplegia

Severe or complete loss of motor function in the lower extremities and lower portions of the trunk. This condition is most often associated with spinal cord diseases, although brain diseases; peripheral nervous system diseases; neuromuscular diseases; and muscular diseases may also cause bilateral leg weakness (Webster's dictionary, 2004)

Paresis

A general term referring to a mild to moderate degree of muscular weakness (Webster's dictionary, 2004)

Participation

Involvement in a life situation (WHO, 2001)

Personal factors

The particular background of the individuals life and living and comprise factors that are not a part of the health condition or health state. These factors may include gender, race, age, fitness, lifestyle, habits, upbringing, coping style, social background, education, profession, past and current experience (past life events and current life events) overall behaviour pattern and character style, individual psychological assets and other characteristics, all or any of which may play a role in disability at any level (WHO, 2001)

Polio

An acute viral disease marked by inflammation of nerve cells of the brain stem and spinal cord

Primary caregiver

A person who is responsible for attending to the needs of the PwD.

PwD

A person with a disability

Rehabilitation

A goal-oriented and time-limited process aimed at enabling an impaired person to reach an optimum mental, physical and/or social functional level, thus providing her or him with the tools to change her or his own life. It can involve measures intended to compensate for a loss of function or a functional limitation (for example by technical aids) and other measures intended to facilitate social adjustment or readjustment. (WHO, 1980)

Social facilitator

Actor that makes progress to contribute to the well being of a community

Spina Bifida

Birth defects caused by closure of one or more vertebral arches of the spine, resulting in malformations of the spinal cord. The spinal membranes and spinal cord may protrude through the absence of vertebral arches Spina bifida results in varying degrees of paralysis, absence of skin sensation, incontinence, and spine and limb problems depending on the severity and location of the lesion damage on the spine. In very rare case, cognitive problems also result

Spinal Cord Injury

Physical damage to the extension of the central nervous system that is enclosed in and protected by the vertebral column. It consists of nerve cells and their connections (axons and dendrites), with both grey matter and white matter, the grey surrounded by the white. Injury is often caused by violence, accident or fracture. The injury is classified to the medical code of the vertebral columns and segments. These segments are (in order from top to bottom): the cervical, thoracic, and lumbar vertebrae, and the sacrum and coccyx. Spinal Cord Injury results in paralysis of the body. The higher the injury is situated, the more severe the paralysis will be.

Technical facilitator

Actor that makes progress to provide technology. This includes manufacturers, designers, dealers, maintenance and repair facilities.

Therapy

Professional treatment to improve the body functioning or condition of the body

Training

Activity leading to skilled behaviour of using a wheelchair.

Technology

Concept of technology comes down at two related items:

Product technology: the body of knowledge, ways and means which is applied for the design and specification of the goods and services to be produced.

Production process technology: The skills and knowledge embodied in machines (Technoware, man (Humanware), information (Infoware) and organization (Orgaware), applied for the production of goods and services required by a society in which and by which it is being used. (Van Egmond, 1998)

Technoware

Refers to the object-embodied technology and consists of such items as tools, equipment, machines, vehicles and physical infrastructure. (ESCAP, 1989, p. 111)

Humanware

Refers to the person-embodied technology and includes aspects such as knowledge, skills wisdom, creativity and experience of individual human beings or groups of people. (ESCAP, 1989, p.109)

Infoware

Refers to the document-embodied technology and relates to aspects such as processes procedures, techniques, methods, theories, specifications, observations and relationships described in publications, documents and blueprints. (ESCAP, 1989, p. 109)

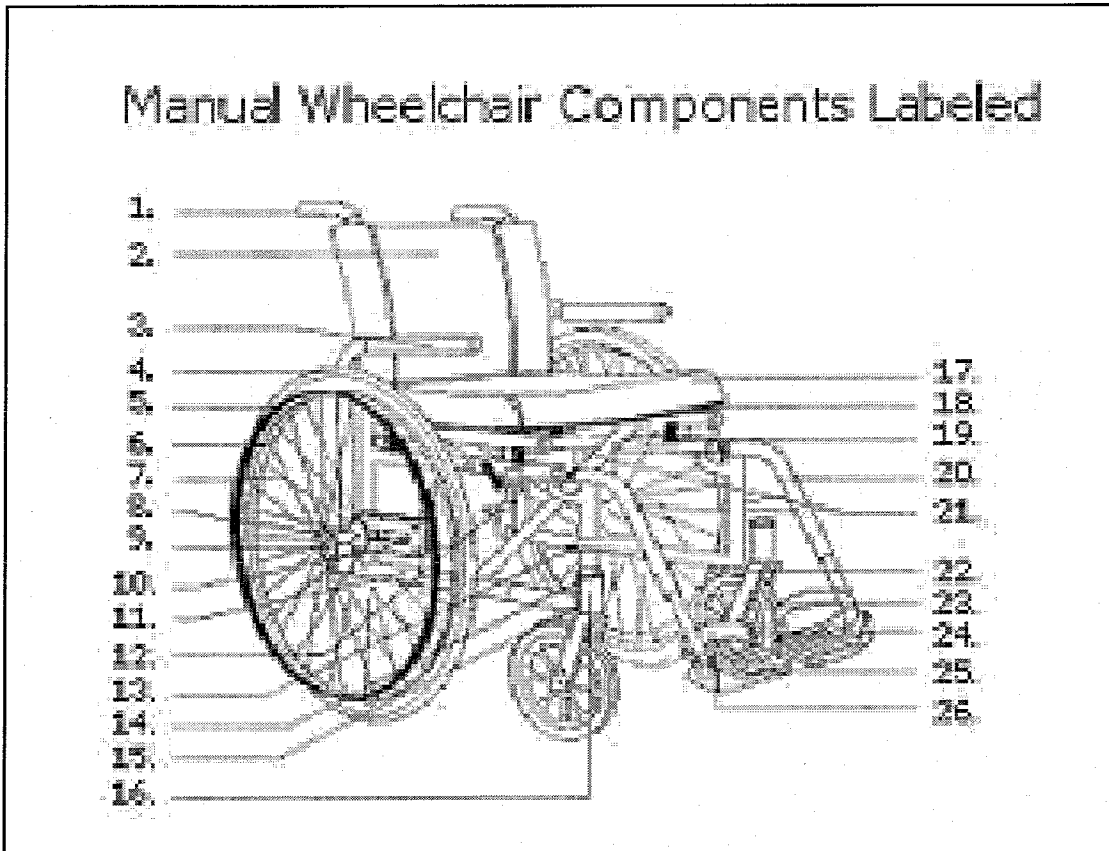
Orgaware

Refers to institution-embodied technology required to facilitate the effective integration of Technoware, Humanware and Infoware and consists of management practices, linkages and organizational arrangements. (ESCAP, 1989, p. 110)

Wheelchair

A device used for mobility by people for whom walking is difficult or impossible due to illness or disability (<http://www.wordiq.com/definition/Wheelchair>)

Glossary of Manual Wheelchair Components



- | | | |
|--------------------------------------|---------------------------------|---------------------------------|
| 1. <u>Push handle bracket tube</u> | 10. <u>Axel plate</u> | 19. <u>X-Hinge</u> |
| 2. <u>Backrest</u> | 11. <u>Frame</u> | 20. <u>Swing-away foot rest</u> |
| 3. <u>Swing-away, padded armrest</u> | 12. <u>Rigid wheel lock</u> | 21. <u>Crossbrace</u> |
| 4. <u>Pneumatic tire</u> | 13. <u>Swing-away release</u> | 22. <u>Caster fork</u> |
| 5. <u>Aluminum handrim</u> | 14. <u>Caster housing cover</u> | 23. <u>Caster wheel</u> |
| 6. <u>Aluminum wheel rim</u> | 15. <u>Caster plate</u> | 24. <u>Caster tire</u> |
| 7. <u>Spokes</u> | 16. <u>Caster housing</u> | 25. <u>Flip-up foot rest</u> |
| 8. <u>Rear wheel hub</u> | 17. <u>Seat cushion</u> | 26. <u>Heel loop</u> |
| 9. <u>Release axel</u> | 18. <u>Seat sling</u> | |

(D. Michael McKeough, PT, EdD Associate Professor Division of Physical Therapy, 2004)

List of abbreviations

ATD	Assistive Technology Device
ATS	Assistive Technology Service
CMDC	Chiang Mai Disabled Center
CP	Cerebral Palsy
DCC	Disabled Campus Club
ICF	International Classification of Functioning, disability and health
INGO	International non-governmental organization
FDC	Foundation for Disabled Children in Thailand
FEPDP	Foundation to Encourage the Potential of Disabled Persons
NCDC	Northern Child Development Center
NGO	National non-governmental organization
PwD	person with a disability
SES	Senior Expert Service
UN	United Nations
WHO	World Health Organization
FWW	Freedom Wheelchair Workshop