The demand, supply and provision system of the Rehabilitation Technology market in Europe: a modelling perspective

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The demand, supply and provision system of the Rehabilitation Technology market in Europe: a modelling perspective

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Abstract

Modelling of the Rehabilitation (Assistive) Technology (RT) market as introduced in this paper, facilitates a multi-disciplinary and formal analysis of the RT domain, by identifying and interrelating the appropriate abstract entities whose value and relevance are widely appreciated. In particular, three notions are explored, namely, the demand for RT goods, the provision system and the supply of RT goods. Demand and supply are modelled in terms of the key elements which can be extracted from the environment of a demand-related or a supply-related actor respectively. The provision system, on the other hand, is analysed adopting a systems approach, being considered as a complex "human activity system" whose functional purpose can be described in terms of a dynamic interaction between the field actors, the activities they engage in and the relevant set of factors which affect the system's behaviour.

Key words

market element, area, actor, factor, process, product design strategy, product launch strategy, demand, supply, specialisation abstraction, RT product taxonomy, functional assessment, human activity system

Introduction and Background

This paper presents a preliminary conceptual framework for identifying and analysing the interactions between the relevant market elements which affect or influence the demand, supply and provision of goods in the Rehabilitation (Assistive) Technology (RT) market.

The RT market is defined as the totality of activities (on the demand and supply side). Goods (products and services) are produced / provided / traded / utilised in some way by the various actors in the Rehabilitation field, including disabled and elderly people.
The RT market in Europe can be characterised as being dominated by small and medium sized enterprises addressing local, regional, sometimes national and occasionally international markets. Despite their small size, these firms are multi-product firms and usually do not limit themselves to RT goods, but produce them along with conventional goods (CORE Consortium, 1992). Moreover, in such firms a degree of complementarity between the RT goods produced and conventional / traditional product lines may be expected, although this need not necessarily be so. From this point of view, specialisation in production is not very widespread.

The companies tend to specialise in particular sectors of the RT market and usually address rather narrow market segments. Thus the RT market is very fragmented. This situation is sub-optimal for all parties concerned (Stephanidis et al., 1992; Stephanidis et al., 1993b). Competition among producers is limited and tends to be of the product differentiation type rather than price. The oligopolistic structure of the market seems to predominate the operation and behaviour of the relatively small number of companies which are active in the field. Besides the small size of the market, a possible reason why it remains oligopolistic may be attributed to the interventions of third-party payers (e.g. insurance organisations) or other intermediary organisations. These are individuals or organisations who have been given by law the task to assess disabled or elderly people and prescribe solutions. Such organisations prefer dealing with a few of the larger companies rather than with many small ones, hence the oligopoly. A statement of issue is, therefore, that the decision of what technical aid the consumer is likely to be prescribed is highly a function of an interpretation of the consumer needs by an intermediary actor. This is obviously the case for products covered by a national provision system.

**Defining the domain to be modelled, terminology and statement of the problem**

The RT market is considered in the present context as the interaction of three abstract concepts; actors, processes and factors. The contextual meaning of these terms has been defined in (CORE Consortium, 1992; Stephanidis et al., 1992; Stephanidis et al., 1993a). This abstraction serves a twofold purpose. Firstly, it facilitates an overall understanding of the workings of the market. Secondly, it directs the decomposition process that should be applied during the actual modelling of the market.

A first attempt to categorise the RT market processes is depicted in Figure 1. The diagram provides an overview of the current problem facing users and manufacturers of technical aids and some of the relevant high level processes that may be encountered. A distinction is made between processes relating to the demand for and supply of technical aids respectively. Once a need has been identified, several questions and actions are triggered off:
Product/service availability is the process of finding out what is available in the market place. Following this, the product/service acquisition processes are initiated in order to facilitate the provision of a technical aid to the end user.

Figure 1: The Rehabilitation Technology market activity diagram

The next relevant question addresses the providers of products and services who operate the services or produce, manufacture, distribute or sell technical aids. This eventually leads the analysis to a specific product or service.

From the supply side, the processes which arguably play an important role are the product/service requirements specification, market analysis and the establishment of methods for approaching the market. Product requirements specification enables the manufacturer to upgrade existing product lines or to define new ones in the light of the latest (recent) trends. Then, the market analysis which follows, reveals the several economic factors which the supplier of the aid must take into account (e.g. the existence of a market, the size of the market for the new product, existing barriers to entry, substitutes, competition, etc.). Finally, the methods for approaching the identified market must be established.

The RT market structure, as described earlier, in conjunction with the inefficiently operating distribution channels provided by the provision system, have created communication gaps between market actors and end users (Stephanidis et al., 1993b). The problem can be summarised as follows: Field actors (i.e. product developers, manufacturers, suppliers, researchers, etc.) do not have sufficient knowledge of the end user needs and requirements
which is required to produce high quality products meeting those needs and requirements. At the same time, efficient and clearly identifiable channels for collaboration during product development are lacking. As a result, disabled and elderly people, and particularly those of employment age, are caught in a vicious circle whereby lack of RT provision, absence of proper training and high unit prices, mean they are not enabled to contribute and be integrated within the community by working (Stephanidis et al., 1992; Stephanidis et al., 1993b). The situation is made more difficult by the fragmentation of the market and the frequent absence of appropriate information.

Modelling, therefore, is conducted in order to provide an insight (i.e. describe, characterise and eventually predict) into the details of a complicated domain, as well as the viability of alternative courses of actions, given some conditions specified by the user of the models (i.e. decision makers at regional, national, EC levels and key RT actors who may be in need of the information derived through the models). The result of this modelling work is intended to be a methodological tool, which in the hands of the appropriate user, will facilitate effective, short and medium term decision making in a structured and constructive manner, through the provision of useful analytic answers to user questions. A longer term objective of work in progress, which however lies beyond the scope of this paper, is the construction of quantitative models of selected market domains, based on the evidence of a body of knowledge gained through the experimentation with conceptual and analytic modelling work. Part of this modelling work is described in this paper.

Some preliminary results: Extracting and characterising the market elements

According to the definitions in (CORE Consortium, 1992; Stephanidis et al., 1992; Stephanidis et al., 1993a), an element is a basic component of the market concerning or affecting either the demand and/or the supply side. Seven market elements have been identified within the boundaries of the RT market, namely, research, development, production, financing, trade, service delivery and usage. In this section, the discussion focuses on a preliminary description of the market elements.

Figure 2 is a pictorial representation of the elements and their relationship. From this diagram, it becomes apparent that the interaction between the seven market elements evolves around the concept of the RT product, its purpose and utilisation in the wider RT market. In this context, the interaction between the elements of research, development and production will be referred to as the *product design strategy*, whereas the interaction between financing, trade and service delivery, will be called the *product launch strategy*. Both strategies are extremely important for the market success of any particular product. Moreover, the two strategies should be closely linked so that input/output procedures from one into the other can be effectively facilitated.
The conceptual relationship between the RT good and the element of usage highlights the notion of user satisfaction and derived utility as a result of using the product. In general, a user will be satisfied by a particular product if and only if the product meets his/her primary and secondary needs and can be acquired efficiently (i.e. at adequate cost) and effectively, given the various constraints (e.g. financial constraints, time constraints, consumer resistance, etc.) of an individual user (Cooper, 1991; Schaffrina, 1991; Loud and Tschirgi, 1991).

From the above summarising statement, it can be argued that, ideally, as the broad RT consumer group expresses demand for RT products, research provides basic data, interdisciplinary knowledge and principles of operation of these products. Industrial research departments transform the basic findings and the laboratory findings into technical specifications and final products through the *product design strategy* (e.g. research, product development and production). Following this, the *product launch strategy* could utilise and build upon the input knowledge accumulated in the course of the *product design strategy*. As already stated, the *product launch strategy* comprises decisions regarding the financing, trading and delivery mechanisms to be applied for any particular product. However, the above description does not represent a faithful reflection of reality in the European Rehabilitation Technology market.

Obtaining a conceptual view of the market elements and their interaction, reveals a variable strength in the relationships amongst the above elements at any point in time. This means that depending on the national provision system, as well as other qualitative factors, the strength of interaction between a relevant subset of the market elements may be imposing a particular structure on the workings of the market, which in turn, results in a higher circulation of products, information and financial resources amongst that specific subset of elements. Thus, actors in such elements may be expected to experience considerable activity turnover and...
economic power, whereas actors involved in the remaining elements may be confronted with considerable operating barriers, reduced RT turnover and market share, etc. Such actors may then decide to attain alternative courses of action in trying to retain a sufficient level of economic activity.

It becomes apparent, therefore, that specific market elements can be expected to affect the market more than some other elements. The decision as to which group of elements will become more influential in the wider market is obviously not arbitrarily made, but the criteria to be applied for such a decision are beyond the scope of this paper.

**Abstracting from the demand side of the RT market**

All successful technical aids share a common characteristic, which in contrast, can not be identified in products which fail to attract market attention, the characteristic being that their development and design iteratively identified and accommodated user needs, experience and future expectations (CCPT, 1990; Ekberg et al., 1991). In other words, user opinion has been strongly taken into account through the analysis of user surveys and the evaluation of technical reports produced by various research and test institutes.

![Diagram](Figure 3: The Demand side of the Rehabilitation Technology market)
Adopting the view that consumer needs should form one of the prominent principles for product development, one can easily deduce that such needs should attract some attention in the context of this analysis. Figure 3 is a high level pictorial representation of the demand for technical aids.

The factors influencing human needs have been extensively researched in the literature and many theories have been formed and tested. Such factors are motivation, roles, attitudes, etc. They are not explicitly examined here, since they come under the umbrella of cognitive science, constituting the domain of discourse of the organisational researcher or the analyst of organisational behaviour. However we are content with accepting the value and the relevance of such theories.

The filtering process shown in Figure 3, demonstrates the workings of a market which has been traditionally dominated by intermediaries. The filtering of human needs encapsulates the translation of consumer needs into a need-driven but filtered demand, which forms one of the RT market driving forces. Filtering of consumer needs may be an iterative process involved in both the demand and supply of technical aids. Nevertheless, it is important to note that given this filtering of consumer needs, purchasing power is not expected to be a prominent demand determinant for products covered by a national provision system; it should be also noted that there are products which may not be covered by a national provision system.

The process is triggered off once a special need is realised. Consequently, a functional limitation is identified following a functional assessment, thus defining the boundaries of a handicap. The functional assessment itself is not a straightforward task and studies have revealed that it may vary depending on the perspective from which it is conducted (e.g. consumer vs. rehabilitation specialist perspective; Batavia, 1992). The next stage is concerned with establishing a mapping between the functional requirements as revealed by the functional assessment and the assistive device which can be used. The term need-driven but filtered demand is used to reflect the goodness of fit of this mapping.

Nevertheless, it is important to realise very early in the discussion that much of the rehabilitation work is still performed by professionals who "know best" what the needs of people with disabilities are. These attitudes may be linked with professional interests which may sometimes overshadow the interests and preferences of the individual.

Abstracting from the supply side of the RT market

The supply of technical aids is seen as the interaction of five abstract entities which underlie the performance of the supply related actors, as shown in Figure 4. For each force acting in this part of the market, a classified analysis has been carried out aiming to enable the evaluation and location of an actor within the general framework, given the particular legal status of the actor (i.e. whether a commercial / industrial firm, charity, user
organisation or research institute), the current utilisation of existing technologies and methods of production.

The application domain or domain of specialisation refers to the product-specific activities in which the company currently engages. The classification scheme shown in the diagram of Figure 4, illustrates a useful but non-exhaustive categorisation of application domains. It can be seen that the domains proposed have been selectively chosen to provide a superset of the human need classification scheme. In other words the interaction of various categories of human needs give rise to product(s) which fit under the umbrella of an application domain. It should be noted, however, that alternative classification schemes may be defined and used depending on the specific objectives (e.g. classification scheme according to ISO sectors, ISO segments, functional limitation, impairment category, handicap, etc).

![Diagram of Quality Control & Maintenance, Technology, Application Domain, Product Suppliers, Care Provision System]

Figure 4: The Supply side of the Rehabilitation Technology market

Firms are seldom active in all application domains due to the complexity involved in operating on such a broad level. Thus, suppliers are usually restricted (due to capital / labour / technological or other barriers), to focus on a relevant subset of specialisation domains that
they consider cost-effective. Focusing on a particular subset of application domains, demands a strategic decision with regard to resources to be used, technology to be applied and so forth.

Moreover, as shown in the diagram of Figure 4, there are theoretically several technologies which either have had an effect or are expected to have an effect on rehabilitation. Firms usually cannot utilise the entire technological spectrum. As a result, they choose only a relevant subset of technology, given their resource constraints. Technology may be expected to bring about innovation in quality control, maintenance and production. Quality control and maintenance are two key issues in determining the quality of a product (Brubaker, 1988).

The Provision System

The provision system, from a medical perspective, represents a three phase process; the preventative phase, the interventionist and curative phase and finally the rehabilitative phase (Gullen and Moran, 1991). For the purposes of this paper, it could be argued that the primary function of the care provision system is to concentrate on the definition of functional requirements, their translation into technical requirements, the mapping of the technical requirements onto specific products and subsequently the provision of the selected aid to the end user. Functional assessment, as already stated, focuses on the user requirements. Health professionals, rehabilitation specialists along side the user and/or a user organisation are the prominent parties involved in functional assessment. On the other hand, technical assessment focuses on the mapping between the user/client and a set of products which must meet the conditions identified through technical assessment and the requirements translation.

One methodological approach for the analysis of the provision system would be to concentrate on the purpose and intended goal of the provision system as defined by a particular RT actor group (RT relevant activity perspective). An equally valid approach, however, would be to focus on the semantics of RT goods (i.e. products and services). Following the RT relevant activity perspective leads to considering the provision system as a "human activity system" (Checkland, 1981). On the other hand, analysing the RT goods suggests that distinctions should be made regarding the nature and type of provision associated with different RT goods.

The RT good-related perspective

It is commonly accepted that a broad range of supporting activities may be required by disabled and elderly people (Gullen and Moran, 1991). Although these may be organised in a variety of ways, four sets of distinctions are especially useful for the present purposes. These are:

- tangible versus non-tangible form of support
- different intensity of care required versus the type of good
- the relative locations of the carer and the cared-for
- how the goods are provided (e.g. on-loan or otherwise)

First, a distinction must be made with respect to the nature of a good, and especially between tangible and non-tangible forms of support. Tangible support refers to all RT products and services which may be needed by disabled and elderly people. Intangible support, on the other hand, covers a variety of social and emotional contributions including companionship, intimacy, re-assurance and psychological security. As far as tangible care is concerned it is common to distinguish between health care and social services to the individual.

Secondly, there are distinctions based on the intensity of care required by the various groups of disabled and elderly people. This covers both tangible and intangible care. In (Gullen and Moran, 1991), it is argued that the intensity of care required by disabled and elderly people can be considered as short-interval, long-interval and critical interval care.

Thirdly, distinctions can be made based on the relative location of the carer and the cared-for. Within the care provision system, emphasis is placed on provision of care within the community rather than in centralised institutions. This means bringing care to, or near to, disabled and elderly people.

Finally, a distinction must also be made between RT products which are provided on loan to the client, or otherwise. This aspect actually addresses two important attributes of a RT good. These are the need for permanent or non-permanent use of a product or service and the current policy associated with the acquisition of that product or service.

The RT relevant-activity perspective

As already stated, care provision in the context of disabled and elderly people is a multi-disciplinary process involving many different parties whose objectives and world views of the care provision system differ considerably. Exhaustive analysis of care provision, therefore, means that all such views must be addressed and taken into account.

A first attempt towards this aim has been made and the results are presented in Figure 5. This diagram, illustrates a general definition of the system from the viewpoint of disabled and elderly people. Having said this, it is argued that alternative interpretations of the steps involved in the provision system are likely to be valid when considered from other "world views"; for example that of the health professional, or the rehabilitation specialist. In other words, the meaning attached to, and the interpretation of, each step involved in the sequential process by the different world views is likely to be substantially different. Indicatively, choosing an aid, is a critical stage in the process whose outcome is subject to a participant's world view (Batavia, 1992). Should that be the health specialist, or the rehabilitation engineer or even the user, the selected aid may be different because of the differing perspectives of the three named categories of participants.
Discussion and related field work

The Rehabilitation Technology product taxonomy, proposed in Vernardakis et al., 1993, is obviously relevant to this work since it highlights some concepts which either implicitly or explicitly characterise some of the issues raised and addressed in this paper. This taxonomy is constituted by a set of four criteria, namely:

- criteria depicting the market structure;
- criteria describing the economic environment;
- product based criteria;
- technology-based criteria.
Each of the above criteria may be satisfied by applying the constructs suggested in (Vernardakis et al., 1993). For instance, the market structure criterion involves specific constructs such as, the type of market structure, competitive strategy, level of competition, intensity of competition, etc. On the other hand, constructs for analysing the economic environment may involve price levels, rate of growth, potential growth, institutional factors etc.

In Figure 6, a pictorial representation of the RT product taxonomy is shown, where ISO sectors (level 1 of the ISO 9999) are vertically listed and evaluated against a set of well defined criteria. The criteria shown in Figure 6, are only an indication of the sort which may be applicable for RT products.

ISO sectors in this context, as indeed ISO segments and specific RT products, reflect a specialisation of the application domain abstraction introduced earlier in this paper. In other words, an ISO sector/segment may be considered as an application domain (see Figure 4) and consequently investigated by applying selected criteria of the Rehabilitation Technology product taxonomy. An example may be used to demonstrate this principle.
Consider a manufacturer of hearing aids who may wish to know whether he should expand geographically into a new market (i.e. a European country). Appropriate product-based criteria from the Rehabilitation Technology product taxonomy may be used to distinctively identify the characteristics of hearing aids in general (i.e. type of product, the purpose of the product, the population they are aimed at, provision methods, etc) as well as the size of the target market, the product-specific determinants of demand (Stephanidis et al., 1993d). Similarly, it is possible to analyse ways of approaching this market by applying appropriate constructs related to the market structure and economic environment. Such an assessment may declare that the target market is oligopolistic and consequently price wars may introduce barriers to entry, etc. Finally, application domains, whether ISO sectors or segments may also be considered in terms of the functional needs they address. Consequently, the conceptual link between technologies and application domains depicted in the diagram of Figure 4, may be explored to identify technologies which could be used to serve the functional requirements of a particular application domain. In other words, a Technology versus Functions (of an application domain) matrix may be constructed to analyse existing products and suggest new ones; suggest technologies which could be used; identify technologies which exist or needed to be transferred, etc.

In the same manner, the taxonomy could be used for analysing different levels in the ISO classification (i.e. ISO sector or ISO segments) depending on the objectives of the study conducted.

As a result, the product taxonomy is useful for at least two reasons, namely:
- to assist in analysing RT products and selecting appropriate case studies
- to provide the link between demand driven analysis and supply driven analysis respectively

With respect to the first objective, the taxonomy can be quite useful in analysing a particular product and finding out:
- its economic environment (e.g. market structure and level of competition);
- importance and performance levels;
- existence of economies of scale for a particular product;
- what are the underlying technologies, driving new product development;
- whether or not innovation is critical to the product success;
- the type of innovation (e.g. product innovation, process innovation, supply pull, demand push), etc.

However, such an analysis is also useful for the market analyst since it links demand and supply specific concepts, thus enabling the interested actor to decide on what products exist in a particular application domain, what adaptations need to be made to these products, if they are to be used in a different environment or by a different target group. Also it provides hints with regards to technologies of the current or future paradigm, their utilisation, synergies
and strategic use. Finally, it helps to establish meaningful associations between human needs, product specifications, application domains (e.g. market areas, ISO sectors, ISO segments) and underlying technologies which already have, or may have, the potential to improve the current market conditions.

Summary and conclusions

The primary objective of this paper has been to present in a brief and concise manner a particular subset of models of the RT market, relating to the demand, supply and provision system for RT goods. Modelling such constructs is clearly a valuable activity which may give results which are potentially useful tools for a formal assessment of a product's position within the wide and versatile domain of the RT market. In addition, such tools may also serve documentative and communicative purposes towards achieving some sort of consensus amongst interested RT actors regarding key issues within a complex and versatile RT market. The results reported in this paper reflect the preliminary findings of work currently in progress.

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