Facing the global challenge to raise the innovation power of agrifood companies; Creating an innovation assessment tool.

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Abstract

The Wageningen Innovation Assessment Tool (WIAT) aims to assess the critical success factors by comparing successful and failed innovation projects in companies. Using WIAT at milestones, it helps companies to improve innovation project execution, raising the success rate of market introductions, and strengthening their competitiveness. The aim of this paper is to present and compare the critical factors for innovation performance in agri-food and technology-based companies. WIAT was assessed on the basis of 252 respondents in 67 agri-food projects and 281 team members in 47 technology-based projects. It is concluded that the potential of products and availability of adequate project resources, as well as good team cooperation, are among the most important determinants of successful innovation in the agri-food sector. The differences between agri-food companies and technology-based companies are mainly located in the field of resources and novelty of the innovation. Adequate project and marketing resources are more important success factors for agri-food than for technology-based companies. This can be explained by the longer experience of the latter with building an innovation project portfolio that balances resources and risks. The fact that novelty of the innovation is significantly more important for the technology-based companies might be explained by the strong consumer orientation by agri-food companies.

Key Words: agribusiness strategies, innovation management

1. Introduction

Sustained firm performance is dependent on the continuous improvement of new products due to the increased global competition, fast development of technologies and continuously changing customer demands. Consequently, it is not a surprise that innovation has received increasingly more attention in the literature and in practice over the years. Firms in the agrifood sector continuously face the challenge of raising their innovation power (Batterink, 2009). The scarce resources available must be attributed to innovation activities while often the outcome of these activities is far from certain. In order to reduce spillage of scarce resources, it is of crucial importance to find an adequate tool which helps companies to make the decision whether to stop, proceed or make an adjustment to their innovation activities at quite an early stage in the innovation process.

Over the years, different tools and techniques have been used to aid innovation processes, such as brainstorming, morphological analysis, synetics, the Delphi method, focus groups, concept testing, in-home use test, quality function deployment, limited roll-out, test marketing, marketing forecast models and computer forecasting (Hollander 2002, Nijssen & Frambach 2000). Reviews have been used to develop the Wageningen Innovation Assessment Tool (e.g. Booz-Allen & Hamilton, 1968; Cooper, 1993, Hollander, 2002; Jamrog, 2006). Wageningen Innovation Assessment Tool (WIAT) detects the strengths and weaknesses of innovation projects, in order to predict their success potential at the start and during the innovation process. While most of the previous studies have delved into other sectors and industries than the agri-food sector, WIAT focuses mainly on the application of the tool and collection of data in agri-food companies in order to strengthen the base of research in this area and contribute to the identification of a robust set of success factors in innovation projects in the agri-food sector. Specific focus on innovation projects in agri-food business has been specified in an earlier paper presented at IAMA and published in the International Food and Agribusiness Management Review (Fortuin, *et al.*, 2007).

WIAT relies on subjective managerial input on multiple criteria (Saaty 1980) instead of purely objective data, to include perceptions and soft information of the innovation project team-members that is not (yet) expressed within the team (Batterink, 2009), for example due to social non-intervention mechanisms, functional specialization, or hierarchy. The analysis of results from the questionnaires may point at early warning signals, which can then be incorporated in discussions, learning, and decision making to enhance the chances to success of the project (Cooper and Kleinschmidt, 1987).

The application of WIAT to different companies over the years resulted in a dataset of considerable size, comprising 533 respondents and 114 innovation projects. The current size of the database enables statistical assessment of the reliability and optimality of the structure of the model behind the tool. Accordingly, in an attempt to present an adequate tool which helps companies to improve innovation project selection and execution, raising the success rate of market introductions, and strengthen their competitiveness, the objective of this study is to test and further improve the validity of WIAT by studying the construct validity and reliability of WIAT. A second aim of this study is to identify a number of critical success factors in innovation processes in the agri-food sector, while comparing the results to earlier findings. In addition, it is being analyzed which factors are more important for agri-food companies and which for the technology-based companies when the two are compared.

2. Theory

2.1 Innovation

The economist Schumpeter (1934) defines innovation as a process of creative destruction, where the quest for profits pushes to innovate constantly, by breaking old rules to establish new ones. For Schumpeter, this implies not only the introduction of new products but also the successful commercialization of new combinations, based on the application of new materials and components, the introduction of new processes, the opening of new markets or the introduction of new organizational forms. Knight (1967) defines innovation as "*the adoption of a change which is new to the organization and the relevant environment*" (Knight, 1967, p.478). '*Innovation is not a single action but a total process of interrelated sub processes. It is not just the conception of a new idea, nor the invention of a new device, nor the development of a new market. The process is all of these things acting in an integrated fashion*' (Myers and Marquis, 1969). Process is the structure of activities and actions which an organization undertakes in order to achieve its goals. Most companies organize the innovation process in projects. Innovation projects can be defined as "*determined plans and routes of development and implementation with the aim to deliver a new product to the market, or new (manufacturing) processes to business"* (Fortuin, *et al.*, 2007, p.4). The stage gate model is often used in order to assess the innovation process by assessing at each stage whether to stop, proceed or change the project. In innovation projects, often cross-functional teams with members from R&D, marketing, manufacturing, and purchasing, co-operate through these stages of idea generation, idea selection and formulation, development of the product/process, testing the product/process, all the way to the actual introduction of the product into the market. The success of a project is heavily dependent on experience and the project context which makes it very difficult to determine what the exact factors are which lead a project to result in success or failure. The limitation of the stage gate assessment is that it only evaluates whether the expected outcomes of the stage in question have been achieved without assessment of how well the innovation process has been executed. The stage gate evaluation does not reveal where the strong and weak points of the followed approach are located.

Fortunately, over the years different studies have delved into the critical success factors in innovation projects. In the review of the past studies on this topic, we will discuss the elements which have been defined as critical to success in innovation projects. It must be noted that most of these studies have been performed in the field of product development projects in high-tech industries, such as the biotech or pharmaceutical industry. Industries, such as the agri-food industry, where predominantly low- to medium-tech innovations are being undertaken, acquired considerably less attention. Due to the fact that the database under study in this paper contains mainly data from agri-food companies, we will compare our findings not only to the success factors identified by the studies which have been performed mainly in the field of medium and high-tech industries, but also to the findings from studies which have delved into the success factors in innovation projects in the agri-food industry.

2.2 Drivers and barriers to innovation

Previous research on factors influencing innovation projects in companies may be predominantly characterized as applied research. The empirical research focused either on factors leading to success (Globe, Levy and Schwartz 1973), factors leading to failure

(Davidson 1976, Hopkins and Bailey 1976; Lazon 1965) or factors that distinguish between success and failure. Brown and Eisenhardt (1995) highlighted three key aspects from past research. First of all, they discern a number of studies, such as the SAPPHO studies (Rothwell 1972; Rothwell et al 1974) and research building on Myers and Marquis (1969), where the emphasis is laid on good planning and implementation, as well as on appropriate and sufficient support to innovation activities as key to success of innovation (Barczak 1995, Calantone et al 1997, Song and Parry 1996). With regard to the planning before the development phase, the preparations for the project include: the first broad evaluation of ideas, execution of technical and market-directed feasibility studies and a commercial evaluation of the innovation project (Barczak 1995, Calantone et al 1997, Song and Parry 1996). Secondly, communication among the project team members, and between the team members and outsiders, as one of the key factors which stimulates performance of the development teams is identified to constitute another important element for successful innovation (Allen, 1966; 1969; 1977). Thirdly, successful product development is seen as a balancing act between relatively autonomous problem solving by the project team on the one hand and strong project management and an overarching product vision on the other (Imai, 1985). Therefore, the organization of work, development process and the product concept require thorough attention if successful innovation is to be achieved.

Other reviews of previous research bring another important element to the surface, the focus on the market. Different dimensions are identified as underlying this aspect. Regular commercial assessment during all phases of the innovation process is crucial as it serves as basis for the decision whether to redefine or terminate a project at certain milestones (Song and Parry 1996). Usually poorly designed projects run too long, as early intervention is considered too sensitive. Therefore, regular assessment, including timely and consequent termination of unprofitable projects could assist to reduce this problem. Secondly, orientation of the innovation process to the market involves the accurate prediction of market potential (Balbontini *et al.* 1999) and competition observation (Calantone & Benedetto 1988, Mishra et al 1996). Ernst (2002) argues that this information should be updated regularly during the entire innovation process. In line with high quality market research regarding the understanding and evaluation of customer needs (Atuahene-Gima 1995, Souder et al 1997; Mishra *et al.* 1995; Parry & Song 1994) is the active involvement of 'lead users' in the innovation process (de Brentani 1989; Rothwell *et al.* 1974; Von Hippel, 1986). Lead users face needs that will be general in a marketplace, however they encounter these needs much earlier than the mass customers. Therefore, involvement of lead users in the innovation process gives companies the opportunity to anticipate market needs.

Cooper and Kleinschmidt proposed that success of innovation projects is mainly determined by the interaction between the market environment, strategic considerations and the execution of the innovation projects. Montoya-Weiss and Calantone (1994) added organizational aspects to this list. These success factors comprise internal as well as external (or contextual) factors. The internal factors are those that can directly be influenced by the management. Under strategic factors are allocated product advantage or superiority; marketing synergy or the fit between the needs of the project and the firm's resources and skills with respect to sales-force, distribution, etc; technological synergy or the fit between the needs of the project and the firm's resources and skills with respect to R&D, etc.; the fit between the company's positioning/corporate strategy and the project; the compatibility of the resource base of the firm with the requirements of the project (capital, facilities, etc.).

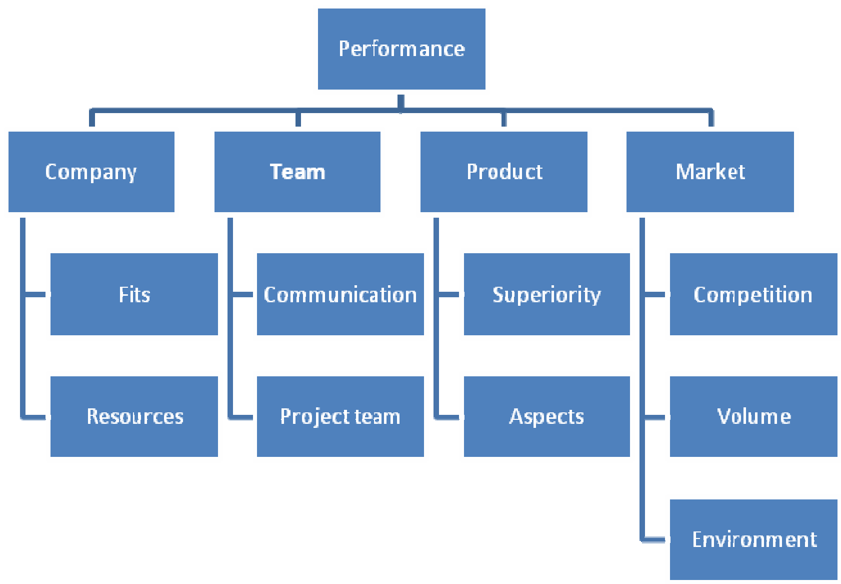
Part of the process development factors are protocol or the firm's knowledge and understanding of specific marketing and technical aspects prior to the project; proficiency of predevelopment activities includes undertaking a set of "up-front" activities like initial screening, preliminary market and technical assessment, detailed market research, etc,; proficiency of technological-related activities (in-house testing, pilot production, production start-up, obtaining necessary technology); top-management support in terms of commitment, involvement and control of the project; speed of development and introduction to the market; the costs of the project or product development; as well as continuous financial and business analysis during all of the stages (development, prior to commercialization and full-scale launch). Organizational factors are related to the internal communication and coordination between the different departments and other aspects of the organization structure of the firm such as the existence of cross-functional teams, level of centralization, reward structure, etc.

External factors may have a direct impact on the accomplishments of the innovation process, but are not directly controllable by the management. External factors primarily relate to market circumstances, technology development (outside the firm), and chains and networks issues (Omta, 2002). In the case of markets and technology, these factors refer to turbulence, degree of complexity, dynamics and unpredictability (market potential or the demand size and growth; market competitiveness or the intensity of competition in the particular market; environmental risks and uncertainties such regulatory restraints). Factors at the chain and network level relate to the balance of power throughout the chain.

3. Conceptual background of WIAT

While making use is of existing knowledge and previous studies, such as the Rothwell's (1972) SAPHHO study, Cooper identified a group of project-related success factors which, although regarded as invisible, are controllable and discretionary (Cooper, 1999). On the basis of this he developed a new assessment tool, NewProd. This tool assesses a number of product development factors related to the company, the product and the market (Cooper 1979). The 48 variables were combined into eight factors: 1) product superiority and uniqueness, 2) project company resource capability, 3) market need, growth and size, 4) economic advantage of the product, 5) newness to the firm, 6) technological resource compatibility, 7) market competitiveness and 8) product customization or specialization. These factors were used to predict the probability that the new product will be profitable for the company. Newprod resulted in an increased understanding of project strengths and weaknesses and generated more insight into the risks, uncertainties and critical attention areas. It provides valuable inputs to go, kill or redirect decisions which resulted in improved resource allocation and it encouraged team building, as using the tool, members of the project team developed a shared vision and direction for the project. As a follow-up to Newprod, Hollander (2002) developed Genesis. Compared to NewProd, Genesis shifts the focus from the company to the team, including items communication and coordination, that proved among the most important determining factors for innovation success. The design of Wageningen Innovation Assessment Tool (WIAT) is related to the NewProd model (Cooper, 1992), but the structure of the model is more directly based on the Genesis model (Hollander, 2002). The conceptual structure of the 53 statements in WIAT encompasses a number of company-internal and a number of external-environment factors (see above the explanation of internal and external factors). The internal dimensions are company (project-company fit and project resources), team (communication) and product (product superiority and product aspects). The contextual dimensions represent market (competition, volume and environment) (see Figure 1). The detailed description of statements used in the questionnaire is set out below.

Figure 1 Genesis questionnaire model (Hollander, 2002)



3.1 Comparison of agri-food and technology-based companies

Studies on critical success factors in innovation projects have been conducted in different areas which leads to the compilation of a broad range of aspects assumed as critical for the success of innovation. Recent studies, while building on past findings, pay more attention to the contextual factors which co-influence the success of innovation projects or new product development (Song & Noh 2006, Blindenbach-Driessen & Ende 2006, Fortuin 2007). In other words, more attention is paid to differences in industries, countries but also size and type of companies, supplier orientation, novelty of products, high/low technology industry, etc. For example, Blindenbach-Driessen & Van den Ende (2006) focused solely on project-based firms. Song and Noh (2006) investigated new product development in Korean firms. WIAT is designed with the focus on the Dutch agri-food sector (Fortuin, 2007). This shift from a broad to a specific context is expected to improve the specificity of the factors relevant to innovation projects in a particular field.

Even though previous studies are conducted in different areas, most of these studies are represented in chemical, software, electronics or banking industries (Ernst, 2002), while the number of studies in the agrifood sector is highly limited. Pannekoek *et. al.* (2005) examined 74 entrepreneurial innovation projects in Dutch greenhouse horticulture whereupon they concluded that product superiority and cooperation with supply chain partners represent the most important success factors for entrepreneurial innovation. Batterink *et. al.* (2006) indicate that a strong market orientation is important for innovating agrifood companies. Economic considerations and insufficient innovation competencies are identified as barriers to innovation in the agrifood sector (Batterink *et al.*, 2006; Garcia Martinez & Briz, 2000), as well as a lack of concrete guidelines for the effective implementation of consumer oriented food development, the sequential approach of the innovation process and the lack of intra- and inter-organizational coordination or integration of research and development (R&D) and marketing activities and know-how (Costa and Jongen, 2006).

On the basis of these previous findings that product superiority is an important factor for innovating agri-food companies and that the agri-food sector is characterized by a strong market orientation, we expect that the results from our comparison tests will show that agri-food companies will score high on product superiority and potential of the product to succeed in the market. Due to their strong focus on the market and the customer, we expect the agri-food companies to score low on product or technological novelty. Strong orientation towards the market and customers usually results in incremental improvements to products or perhaps company-processes (with the purpose to lower prices) rather than technologically complex and highly innovative products, resulting from technological developments. In contrast, it is expected that novelty of the innovation and technological novelty stand out among the crucial factors for successful innovation in the case of the technology-based companies, because their continuous drive for innovation, enticed by the environment wherein they operate.

Following Batterink *et al.* (2006), it is expected that the availability of resources to dedicate to innovation projects will be among the key factors for successful innovation projects in the agri-food. Especially because this is identified as one of the bottlenecks in the agri-food sector, it is expected to illuminate as one of the key aspects where the difference between the successful and failed projects lies. Also in comparison to the technology-based companies, agri-food companies are expected to show a greater importance of the availability of adequate financial, technical, managerial, production and marketing resources as key to successful innovation projects. The greater experience with innovation, and with this a larger pool of resources to attribute to innovation projects, in the case of technology-based companies leads to the expectation that the factors project and marketing resources, although also important for the technology-based companies, are expected to constitute less of a barrier for the latter companies and therefore show to be of higher importance for the success of innovation in the agri-food sector.

As identified by Costa and Jongen (2006), integration of people from different departments or disciplines (cross-functional teams) and concrete guidelines in innovation processes seem not to be the strongest skills in agri-food companies. Therefore, we expect that the factor team cooperation will stand out as crucial for success in innovation project in agrifood companies. However, if we assume that the nature of innovation in the technology-based companies is somewhat more driven by novelty of products, the expectation is that team integration of a greater number of experts and departments is more important for the technology-based companies than for agri-food companies which innovate in a market-oriented way. Therefore, team cooperation is expected to be of great importance for these companies as well.

4. Data collection

Data were collected from 114 successful, failed and running projects from agri-food and technology-based companies, characterized by the presence of a Research and Development (R&D) department and a significant budget to innovation activities. In the comparison tests we included large companies from both, the agri-food and the technology-based companies. Large companies are defined as companies with more than 250 employees and an annual turnover of more than €50 million.

In each of the participating companies contact was established with the R&D/innovation-oriented department, or the project manager from the business unit which deals with innovation in the company, project entrepreneurs or experts, by telephone to explain the intention of the study and to secure a commitment. Subsequently, a number of successful and failed innovation projects conducted by the company are selected, to which the running innovation projects can be compared. "Successful projects are defined as projects that not only are a success in terms of engineering/technological accomplishment, but also perform well after market introduction and generate substantial sales for the company. Failed projects are projects that are either stopped before project completion or market introduction, or prove to be a failure in the market" (Fortuin *et al.*, 2007, p.7).

The present study employs a survey method to collect information on the innovation projects. A meeting is organized with the project leader to complete a questionnaire with general questions about the company profile, the cooperation and sources of information relevant for the project and to adapt the WIAT questionnaire to the specific situation of the innovation project at hand. The tailor-made questionnaire is finally administered to the project team members (sometimes extended with external experts familiar with the project) who are in the appropriate position to provide the necessary information. The minimum number of evaluators of a project was 2 and the maximum was 11 (Fortuin, *et al.*, 2007). The multi-respondent technique enables triangulation of data and reduction of respondent bias.

This questionnaire makes use of a 10 point Likert-scale[1] which gives the respondent the possibility to indicate the agreement with the statement and a 10 point certainty[2] scale which enables us to calculate average answers score, standard deviation on the answer scores, the average certainty scores and the standard deviation on the certainty scores. Analysis of these scores gives a first impression on the situation in the project. The results are compared with the database of the already assessed projects. Final discussions with the team members lead to defining practical suggestions for improvements in the company's innovation projects. The data on the ex-post projects are collected in the same manner as in the case of the running projects. The respondents are asked to answer the questions as if the project was still taking place in order to reduce bias caused by retrospective data collection. For the projects assessed ex post, the same methodology was applied as for the running projects. Although this approach does not eliminate the response bias, it has proven to be effective (Cooper, 1985).

5. Measures and methods

The WIAT questionnaire items are presented here. The two factors under the company construct are project-company fit and project resources. The project-company fit 8-items factor measures to what extent the innovation project fits the company strategy. The 7-items project resources factor measures the level of adequacy of resources and skills devoted to the

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[1] 1 = I totally disagree with this statement and 10 = I totally agree with this statement

[2] 1 = I am completely uncertain about my assessment of this statement, and 10 = I am completely certain about my assessment of this statement

project. The team construct is indicated by a single factor, team communication. The 8 items under this factor measure the extent to which the team members in the project work in an integrative manner. Part of the latter are good technical and communication skills as well as sufficient decision making authority. Under the product/process level two factors are scrutinized, product superiority and product aspects. On the basis of 9 items, the extent to which a product possess distinctive features (a higher quality or unique features) compared to competitors' products, economic advantage, meets certain customer demands, and has a higher probability of achieving success in the market is measured. Three factors are measured under market, market competition, market volume and market environment. Here, the extent to which a new product has the possibility to be sold at the numbers predicted, the extent to which the new product is able to compete with other products or substitute products in the market. In short, on the basis of 14 items, the level of competition and the market attractiveness as well as the level of hostility of the (institutional) environment is measured. Performance is measured along three dimensions: project, process and future performance. On the basis of 7 items, it is being assessed whether the project is executed within planning and budget, and to which extent the original project objectives are fulfilled. It also measured the extent to which the products benefits end-users, is expected to earn money for the company, spin-off products are expected to follow and improvement of customer loyalty is probable. The individual items are incorporated in Table 2.

In order to enhance the statistical quality, first we studied construct validity or the degree to which a measure of a concept truly reflects that concept (Bryman & Bell, 2003). More specifically, internal reliability refers to whether indicators, that make up a scale or index, are consistent (Bryman & Bell, 2003). The optimal structure is reached when the factors are both conceptually meaningful in explanation, and statistically efficient, in particular when each variable significantly loads on one factor only. In order to test and further improve the validity of WIAT we used various methods. After the process of refining of the factors through exploratory analysis, reliability tests were carried out to show the stability and strength of the factors or the construct validity of the tool using Cronbach's alpha (Cronbach, 1951; Churchill, 1979).

Principal Component Analysis (PCA) and Varimax Rotational method was used. The Exploratory Factor Analysis (EFA) provides an initial indication of common factors along with factor weights, factor intercorrelations and unique variances of the attributes (Tucker and MacCallum 1997; Hair et al, 1998; Field, 2000). It determines how many factors might be present and gathers indications of their nature and relationships, which should lead to a better understanding of the factors observed. A second goal of EFA is to achieve data-reduction through identifying representative variables, from the larger set of variables, to reduce the workload in gathering data and simplify subsequent analysis (Hair et al, 1998).

Secondly, we performed a number of comparison tests in order to find out which critical success factors in innovation projects in the agri-food can be detected on the basis of the current dataset. In addition, it is being analyzed which factors are more important for successful innovation in the agri-food companies and which for the technology-based companies, when the two are compared.

6. Results

Prior to the Exploratory Factor Analysis (EFA), we checked and corrected the data on descriptive statistics and missing values. In addition to the descriptive statistics, we analyzed the normality of the distribution of the data on the basis of the values of kurtosis and skeweness. Especially the latter are useful to assess objectively the normality of the distribution. For all of the variables, the values of kurtosis and skeweness do not deviate much from the desirable value, which is zero. Significant values of the Kolmogorov-Smirnov test confirm a slight deviation from normality in our dataset. However, factor analysis can still be conducted because the additional assumptions and requirements for factor analysis are met[3].

Missing values have been examined and those cases where a large number of data was missing have been deleted. Where possible, we have executed imputation on the data on the basis of the mean scores for each factor in the conceptual structure, at the respondent level. This is based on the assumption that a value derived from all other observations in the sample is the most representative replacement value (Hair et al, 1998). We started the analysis with 655 respondents and 155 projects. However, because of the large number of missing values, we continued the analyses with 533 respondents and 114 projects.

Table 1 Number of respondents and projects in the data-set before and after the deletion of cases

Data set	No. of resp. *Before*	No. of resp. *After*	No. of projects *Before*	No. of projects *After*
WIAT set	655	533	155	114
Technology-based sub-set	311	281	47	47
Agri-food sub-set	344	252	108	67

6.1 Factor analysis

Turning to the explorative factor analysis, we have examined the Kaiser-Mayer-Olkin (KMO) of Sampling Adequacy and Bartlett test of sphericity, the degree of multicollinearity and the measure of sampling adequacy (Hair et al, 1998). The KMO[4] value of 0.874 indicates that patterns of correlations are relatively compact which means that factor analysis should yield distinct and reliable factors (Field, 2000). The anti-image matrix indicates Measures of Sampling Adequacy (MSA) well above the minimum of 0.5 which means that we can take all the variables into account when performing the factor analysis. The Bartlett test of sphericity is highly significant (p= 0.000) in our case, which tells us that significant relationships between the variables in our dataset are present which is desirable when performing factor analysis. There is a limited degree of multicollinearity in our case, however as Hair *et al.* (1998) state, even if there is some degree of multicollinearity it is possible to continue with factor analysis.

Initially factor analysis at respondent level was run to trace the useful number of independent factors. Latent root or Eigenvalues served as criterion to extract the factors for the first attempt of interpretation, with 1.0 as the convenient cut off value. Only factor

[3] There is already an underlying structure that exists among the variables in the dataset as explained in the literature review. The dataset contains more than 50 observations, which is the minimum required sample size. Also, there are at least five variables for each proposed factor and the sample size has more observations than variables. In addition, the number of observations per variable is more than ten (Hair et al., 1998; Tabachnick and Field, 1996).

[4] "The KMO statistic represents the ratio of the squared correlation between variables to the squared partial correlation between variables" (Field, 2000, p.455).

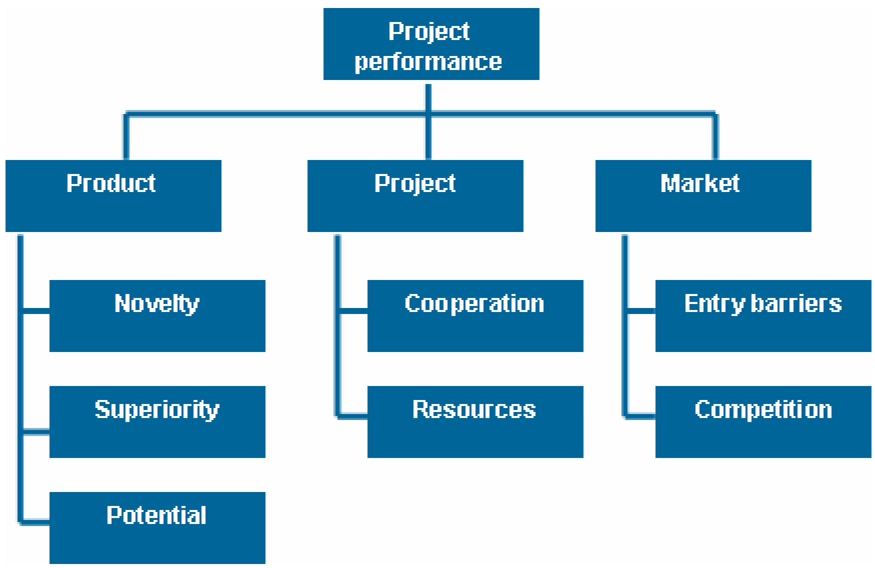
loadings higher than 0.4[5] are taken into account. Our intention was to 'let the data speak' or in other words to find out what the consequences would be for the initial conceptual structure when the compiled dataset is tested in an explorative fashion. The iteratively-run explorative factor analysis resulted in 9 components. While combining the results from the actor analysis with reliability tests (Cronbach alpha) we came to the conclusion to retain a structure which is conceptually and statistically meaningful, containing 9 factors and 41 variables (see Table 2), in comparison to the initial 53 items. Due to the new component structure which followed from the factor analysis, we had to attach new labels to certain factors or re-label some of the factors on the basis of conceptual considerations. Reallocation of certain items resulted in the following categorization of the factors: product, project and market. Under product we find two dimension of novelty. Novelty of the innovation to the company counts 6 items from the initial factor 'project-company fit' and the technological novelty includes 3 items from the initial factor 'product aspects' and 1 items from 'project-company fit'. Under product, we find also the factors superiority and potential. Superiority contains 5 items mainly from the initial factor 'product superiority'. Product potential contains mainly items from the previous concept 'market volume' and counts 6 items. Under the category project, we find team cooperation and two dimensions of resources, general resources and marketing resources. Team cooperation contains 8 items, stemming from the previous factor 'team communication'. Resources are divided into general resources counting 4 items and marketing resources containing 3 items. The last category, market, includes entry barriers and competition. Each of the two factors count 3 items from the initial factor 'market competition'. Combining the reduction of variables and the reshuffling of items, while renaming the factors, we generated a new structure of the WIAT conceptual model (see Table 2 and Figure 2).

[5] Given the sample size above 500, factor loadings of .40 and higher, are considered significant for interpretative purposes (Hair et al 1998).

Table 2 Structure of the WIAT dataset

Factors and variables	Loading
Product	
Novelty α = 0.757	
The potential customers for this product are totally new for the company.	.614
The nature of the production process is totally new for our company.	.590
The distribution system and/or type of sales-force for this product is totally new to our company.	.784
The type of advertising and promotion required is totally new to our company.	.768
The competitors we face in the market for this product are totally new to our company.	.671
Technological novelty α = 0.797	
The technology required to develop this product is totally new to our company.	.661
Our product is highly innovative and totally new to the market.	.651
Our product is a very high technology one.	.783
Our product is mechanically and/or technically very complex.	.778
Superiority α = 0.813	
Our product will be clearly superior to competing products in terms of meeting customers' needs.	.736
Our product will be of higher quality than competing products.	.641
Compared to competitive products, our product will offer a number of unique features or attributes to the customer.	.689
Our product will permit the customer to do a job he/she cannot presently do with what is available.	.633
Our product will be first into the market.	.627
Potential α = 0.816	
The monetary value of the market (either existing or potential market) for this product is large.	.527
The market for this product is growing very quickly.	.685
Potential customers have a great need for this type of product.	.744
The customer will definitely use the product.	.669
This product has a high potential (i.e can additional products, multiple styles, price ranges).	.672
This project will contribute to the competitive advantage of the company.	.702
Project	
Team cooperation α = 0.858	
I have enough communication with my team members to do my work efficiently and in an effective way.	.702
The portfolio management has explicitly expressed its commitment to the project team.	.591
The performance requirements for this project are clear for me.	.679
In a new project I surely want to participate in the current team again.	.727
I completely understand the potential problems of the project.	.611
If I doubt the opinion of a team member I will surely confront this member with it.	.476
All our team members are focused on "collecting" knowledge for our project.	.725
I am completely satisfied with the product development process used.	.711
Resources α = 0.755	
Our financial resources are more than adequate for this project.	.610
Our management skills are more than adequate for this project.	.523
Our engineering skills and people are more than adequate for this project.	.692
Our production resources or skills are more than adequate for this project.	.653
Marketing resources α = 0.827	
Our marketing research skills and people are more than adequate for this project.	.760
Our advertising and promotion resources and skills are more than adequate for this project.	.839
Our sales and/or distribution resources and skills are more than adequate for this project.	.730
Market	
Entry barriers α = 0.619	
There is a strong dominant competitor – with a large market share – in the market.	.723
There is a high degree of loyalty to existing (competitors') products in this market.	.773
New product introductions by competitors are frequent in this market.	.500
Competition α = 0.791	
The market is a highly competitive one.	.833
There are many competitors in this market.	.798
The market is characterized by intense price competition.	.782

Figure 2 WIAT structure



6.2 Success factors in the agri-food sector

Comparison tests are carried out to find out which factors are crucial for success in innovation projects in the agri-food sector. In addition, a comparison is made between agri-food companies and technology-based companies outside the agri-food sector which attribute a greater amount of time and resources to research and development. We will study these differences on the basis of the construct averages, at the project level, in order to minimize the chance that the results are colored by respondent bias. Because the data deviate only slightly from the normal distribution, we performed both parametric (t-tests) and non-parametric (Mann-Whitney) tests. On the basis of the findings, we decided to base our conclusions on the results from the Mann-Whitney test, but to extend the confidence interval to 90% (1-tailed).

Table 3 Failed and successful projects in the agri-food sector at project level

N= 32	**Agri-food**				
	Success n=21		*Failure n=11*		*Mann-Whitney Sig.*
Factor	Mean	sd	Mean	sd	
Product					
Novelty	2.62	1.09	4.01	2.37	
Technological Novelty	4.67	1.64	5.22	1.91	
Superiority	6.67	1.61	5.84	1.30	
Potential	6.53	1.17	5.43	1.22	**
Project					
Team Cooperation	7.76	0.96	7.03	0.99	*
Resources	7.61	1.16	6.36	1.17	**
Marketing Resources	7.35	1.16	6.39	1.71	*
Market					
Entry Barriers	4.85	1.59	4.64	1.93	
Competition	7.35	1.37	6.55	1.58	

* $p < 0.10$; ** $p < 0.05$; sd = standard deviation

As previously explained, successful projects are those projects which have achieved their objectives (for example the engineering/technological accomplishments), perform well after market introduction and generate profits for the company. Failed projects are those projects which are either stopped before project completion or market introduction or which proved to be a failure in the market (Fortuin *et al.*, 2007). The results of the comparison tests show that the mean scores between failed and successful projects from agrifood companies significantly differ in the field of product potential, team cooperation, project resources and marketing resources. The fact that product potential has a significantly higher score in the case of successful projects is in line with our expectation that potential of the product to succeed in the market as well as product superiority are important aspects in the agri-food sector. However, product superiority itself does not show significantly different scores, but this may be in line with the considerably lower score on novelty of the innovation in case of successful projects which would mean that product innovations in agri-food companies do not necessarily result in very new products with superior features but that their potential is based on other grounds, such as lower prices. Although not statistically significant, the considerably lower score on novelty in the case of successful, compared to the failed, projects shows that companies in the agri-food are apparently more successful when they engage in incremental innovations. These results are in line with the expectation that the strong focus of agri-food companies on the customers effects in incremental improvements rather than technologically complex or radical product changes. Good communication, clear goals and high commitment, as elements of team cooperation, demonstrate to be significantly important for successful projects in the agri-food sector. Furthermore, we can establish, on the basis of the significantly higher score on project resources in successful projects, that companies with more adequate financial, managerial, technical, production and marketing resources are more successful in their innovation activities than companies which have a lower availability of project resources.

Table 4 Comparison of failed and successful projects in technology-based enterprises

N= 19	**Technology-based companies**				
	Success n=9		*Failure n=10*		*Mann-Whitney Sig.*
Factor	Mean	sd	Mean	sd	
Product					
Novelty	4.63	1.66	4.57	1.39	
Technological Novelty	4.05	2.10	4.21	1.61	
Superiority	7.02	1.36	5.77	1.31	
Potential	6.99	0.89	5.87	0.77	**
Project					
Team Cooperation	7.60	0.85	6.50	0.32	***
Resources	6.77	0.80	6.58	0.68	
Marketing Resources	5.79	1.03	5.98	1.41	
Market					
Entry Barriers	5.20	1.36	4.37	1.02	
Competition	5.00	1.71	4.74	1.16	

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$; sd = standard deviation

Product potential and team cooperation are the two factors which prove to be the most significant factors for successful innovation projects, compared to failed innovation projects, in technology-based companies. Team communication, clarity and commitment in cooperation turn out to be important success factors for these companies, as well. We expected that large, technology-based companies, due to their long-standing experience with innovation, and with this a custom to attribute significant resources to innovation projects, would score high novelty and product superiority. However, we did not find a significantly higher score in successful projects, when compared to failed innovation projects in technology-based companies, on the factors novelty and product superiority.

Table 5 Comparison of successful projects in agri-food and technology-based companies

N= 30	**Successful projects**				
	Agri-food *n=21*		*Technology-based companies* *n=9*		*Mann-Whitney Sig.*
Factor	Mean	sd	Mean	sd	
Product					
Novelty	2.62	1.09	4.63	1.66	***
Technological Novelty	4.67	1.64	4.05	2.10	
Superiority	6.67	1.60	7.02	1.36	
Potential	6.53	1.17	6.99	0.89	
Project					
Team Cooperation	7.76	0.96	7.60	0.85	
Resources	7.61	1.16	6.77	0.80	*
Marketing Resources	7.35	1.16	5.79	1.03	***
Market					
Entry Barriers	4.85	1.59	5.20	1.36	
Competition	7.35	1.37	5.00	1.71	***

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$; sd = standard deviation

When we only look at successful projects and compare companies from the agri-food and technology-based companies (see Table 5), novelty shows a significantly higher score in technology-based companies. This is in line with the expectation that technology-based companies come up with products with superior features compared to the agri-food industries. Adequate financial, managerial, technical and production resources show a significantly higher score in successful agri-food projects than in technology-based companies. This difference is even more significant in the case of marketing resources. Previous research found that economic considerations and insufficient skills in innovation constitute important barriers in innovation in the agri-food. This is probably the reason why we find that availability of adequate resources is significantly more important for success of innovation in the agri-food. The technology-based companies, with their more long-standing experience with innovation, probably have larger budgets to attribute to innovation activities and more competencies in the field of innovation which they built up over the years. Finally, competition shows to be a significantly more important factor for both, the successful and failed projects in the agri-food companies than in technology-based companies. This finding might be explained by the rather powerful retail actors which increase the level of competition for the agri-food companies by offering their own brands next to the assortment stemming from agri-food processing companies, while the technology-based companies mainly deal with business-to-business markets with limited amount of competitors. The fact that no significant difference was found in the comparison between successful and failed projects in the agri-food sector (see Table 3) with regard to competition, indicates that the agri-food companies know how to handle the competition effectively.

7. Discussion and conclusions

Years of research into innovation activities of companies brought forward a number of factors important for successful innovation. Next to planning and management support for innovation activities, also the balance between autonomous problem solving by the team and strong project management with an overarching product vision were identified as important factors for innovation performance. In addition, it was argued that team communication and cooperation plays an essential role in improving the performance of innovation activities. Sufficient attention to market needs, in terms of regular commercial assessments and integration of lead users, belongs to this list, as well. Cooper and Kleinschmidt (1993) concluded that success of innovation projects is mainly determined by the interaction between the market environment, strategic considerations and the execution of the innovation process. WIAT was used to measure potential project success in an early stage of development, by bringing the tacit knowledge of the different project members on the table using a 10 point Likert-scale questionnaire. First we studied the construct validity and reliability of WIAT. This resulted in a structure containing 9 factors: novelty of the innovation, technological novelty, product superiority, product potential, market entry barriers, competition, team cooperation, project resources and marketing resources.

The aim of this study was to identify a number of critical success factors for innovation projects in the agri-food sector, while comparing the results to earlier findings and to critical success factors which arise from the analysis of the technology-based companies. As expected, product potential is an important aspect for successful innovation projects in agri-food companies. The lower score on novelty in successful projects, compared to failed projects, although insignificant, leads us to the conclusion that product innovations in agri-food companies should not be too far away from what customers expect. Agri-food companies appear to be more successful when they engage in incremental innovations rather than in radical product changes. As is the case in the agri-food sector, also in the case of the technology-based companies, product potential proves to be a significant factor for successful innovation projects. In contrast to our expectation, product and technological novelty do not emerge as important aspects when we compare the failed and successful projects within technology-based companies. However, when we compared agri-food and technology-based companies, novelty does show to be a significantly more important factor for successful innovation in technology-based companies. This is in line with our expectations that technology-based companies are more inclined to engage in radical innovation.

Findings from earlier studies indicate that a lack of sufficient resources constitutes an important barrier to innovation in the agri-food sector. Our research findings turn out to point in the same direction. Adequate project and marketing resources are more important for innovation activities in agri-food companies than in technology-based companies. Resources are an important aspect for technology-based companies, as well, but because of their longer history in innovation, they are probably more used to build an innovation project portfolio that balances resources and risks. For agri-food companies, attribution of considerable resources to large innovation projects and building a well-balanced research portfolio is not such a long-standing habit as for the technology-based companies. As expected, cooperation showed to be of significant importance for project success in both agri-food and technology-based companies.

This study shows that research into the key success factors for innovation in the agri-food sector can provide valuable insights for companies, bringing forward points which require particular attention in order to guide innovation projects to successful endeavors. Using WIAT, companies can improve their innovation project execution, raise the success rate of their market introductions, and strengthen their competitiveness, by assessing their innovation projects and detect the key aspects which require immediate attention or re-adjustment.

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