CORVINUS
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THESIS SUMMARY

Eszter MONDA

The interconnection of information systems and futures studies and its interpretation in decision support

PhD dissertation summary

Supervisors:

Erzsébet NOVÁKY, DSc
Professor emeritus

Réka Franciska VAS, PhD
Associate professor

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Department of Information Systems

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1. BACKGROUND, SCOPE AND OVERVIEW OF THE RESEARCH

1.1. Research Background and Scope

Futures studies and information systems have developed rapidly, dynamically and in parallel over the past fifty years. This evolution did not take place in isolation but in an organic way with each aspect supporting the other. In parallel with the development of information systems the forecasting and foresight analytical methods are embedded into information systems. **Nowadays any kind of information systems usually contain some level of analytical approach or functions in order to analyse the near or far future.** The ICT (information and communication technology) based methodological support of futures research is an on-going developing area (Durst et al., 2015).

The subject of my research is to explore how the decisions can be grounded by the knowledge of information systems and futures studies. In the course of decision-making, information systems handle the uncertainty that originates from the quantity, quality, validity, structure and processing speed of data. Relying on a scientific basis and tools, futures studies predicts the likely impact of decisions made by us to mitigate uncertainty, which is a concomitant of future. We may presuppose that information systems and futures studies are both able to mitigate uncertainty - while information systems supply real time information and analyse large scale data, futures studies has approaches and methods to create complex alternatives even for the far future.

If a decision-maker wants to find solutions not only for the present but also for the near or the far future, ICT usage in itself will prove inadequate. Analyses concerning the future require the aspects and methodology of futures studies. **By connecting futures studies and information systems we might create a decision-making mechanism which is reliable (i.e. it is supported by data), complex (i.e. it has alternative aspects), creative (i.e. it applies qualitative methods and analyses new changes), desirable (i.e. it relies on participation) and feasible (i.e. it is in the common interest and is based on the consent of various groups) and usable for both the present and the future.**

Connecting information systems and futures studies is a field of many questions to be researched in a world that develops by the day. The research of the mutual effect the two fields have on each other seems quite exciting, since these fields are relatively new, and they both develop and spread rapidly. Combining them and describing how they support one another is a task that may well have scientific significance.

1.2. Research Questions and Overview

The basic research questions are what is the role of information systems in futures studies, what is the place of futures studies in information systems; furthermore, how their combined role can be interpreted in decision support. The **research questions** are the following:

1. How could IT solutions support futures studies? Which methods of futures studies might be supported by information systems and IT solutions and how?
2. How does futures studies appear in information systems? How and with what components, functions and fields of application may the aspects and methods of futures studies contribute to the development of information systems?
3. How could information systems and futures studies support decision-making jointly? With what functions could systems supporting forecast and foresight create an added value to decision-making?

Before answering the research questions, the components (hardware, software, procedure, data, network, person) of information systems as well as its structure will be analysed - thus the relations of information systems and futures studies can be better examined. I shall define the concepts needed to understand this paper in **chapter 2.1.** In **chapter 2.2.** I shall examine the development of futures studies from the aspect of how information systems can make the applications of futures studies methods as effective as possible. In the part that discusses the methodology of futures studies I shall define the IT solutions which promote the research of the future. Chapter 2.2. answers the first research question.

As IT solutions continuously supported futures studies methods, these methods started to appear as functions or solutions in information systems. Information systems use data to formulate relevant statements and conclusions with regard to the future. Development has reached the level that information systems now usually contain an analysis about the future.

In **chapter 2.3.,** I shall be looking for an answer to the second research question, i.e. how can the methods and aspects of futures studies become a new component and organic part of information systems, what ways they appear and what type of added value they represent in the development of information systems. The appearance of futures studies in information systems is definitely a new component that I call "futureware".

I shall analyse this new theoretical concept empirically in **chapter 3.** Chapter 3. surveys the theory set out in 2.3. to statistically analyse how the theory works in business life. Small sample surveying is of course not adequate to prove a point, however, it may bring us closer to the practical approach of the concept.

In **chapter 4.** I shall examine the practical uses of information systems and futures studies in decision support. Acquired practical information will be compared to theoretical concepts and approaches. The objective of this analysis is to define the new component of the information system with the particular functions of decision-making systems. My specialised background knowledge and consultations led me to the conclusion that the research of systems promoting forecast and foresight can bring me closer to answering how these two fields actually support decision-making. By analysing systems I attempt to see how systems actually support the decisions that affect the future. I shall discuss whether the decisions rely on a solid futures studies basis, with regard to structure, functionality, process and aspect. The definitions of system functions will be based on background literature, case study analyses and analyses of certain systems. The chapter may give an answer to the third research question.

2. RESEARCH METHOLOGY AND CONCEPT

2.1. Research Methodology

I consider my survey a humble pioneering into the exploration of a new phenomenon about which we only have vague ideas (Brown, 2006). I won't formulate hypotheses, I will simply use my research questions as a guideline to examine the connections of information systems and futures studies and their joint impact on decision support. In many cases in the past, informatics did employ forecasting and foresight methods and analysed the effects of IT solutions on the future, however, the role of futures studies has not been examined systematically thus far. Many researchers of futures studies (Bengisu – Neklihi, 2006; Bodon, 2006; Comes et al., 2015; Dalal et al., 2011; Durst et al., 2015; Gnatzy et al, 2011; Godet, 2000; Gordon – Pease, 2006; Markmann et al., 2013; Mietzer – Reger, 2005; de Miranda Santo et al., 2006; Vág, 2005; von der Gracht et al, 2015; Walden et al., 2000; Woo et al., 2015) analysed the IT solutions that were helpful in the research of the future, however, they did not separate different levels of relations between the two fields. This vacuum spurred me to reveal connections between information systems and futures studies. My **research is exploratory** mainly because the intersection of the two fields has so far been unexplored. In the course of exploratory research I shall be looking for connections and correlations between variables, as well as explanations for the latter. The formulated questions will be answered by applying inductive logics. Inductive reasoning draws general conclusions from observations and their correlations (Neuman, 2003). The process starts with examination, followed by observation and concluded by theory formulation (Bryman – Bell, 2003). Inductive logics is often supplemented by qualitative research (Ghauri – Grønhaug, 2011) such as background

literature synthesis, surveying and case study analysis, which I also employed. When reviewing literature I shall examine the ways by which IT solutions supported futures studies targets, and the place futures studies was able to take in information systems. A synthesis of relevant articles served to reveal and understand the relation of the two fields. In the course of analysis, particular cases are used as sources to formulate pieces of new theoretical knowledge (Ghauri – Grønhaug, 2011).

As a result of combining theories, I shall define a new information system component that relates to functions of computer-aided analyses targeting the future. I shall take the elements of experience from cases discussed by pieces of background literature. They will be used to formulate the theoretical concept of futureware as a general conclusion. Concepts in research are coined to describe a phenomenon: they increase the communicational basis, present a certain viewpoint and promote understanding (Ghauri – Grønhaug, 2011).

Coining a phrase is never enough, it should also be tested - therefore, a survey was conducted to prove the concept. Surveying served to check whether experienced experts also perceive that futures studies and IT solutions support each other and whether they also acknowledge the importance of the intersection of the two fields.

After examining the concept I shall peruse available literature on the systems supporting forecasting and foresight in order to examine the concept in practice and reveal correlations. After consulting literature I deepened my research with case studies in which the applicability of forecasting and foresight support systems was analysed in actual projects. The method of case study analysis is a suitable tool to test the formulated theory because it is able to give answers to questions starting with "how" and "why" (Yin, 1994).

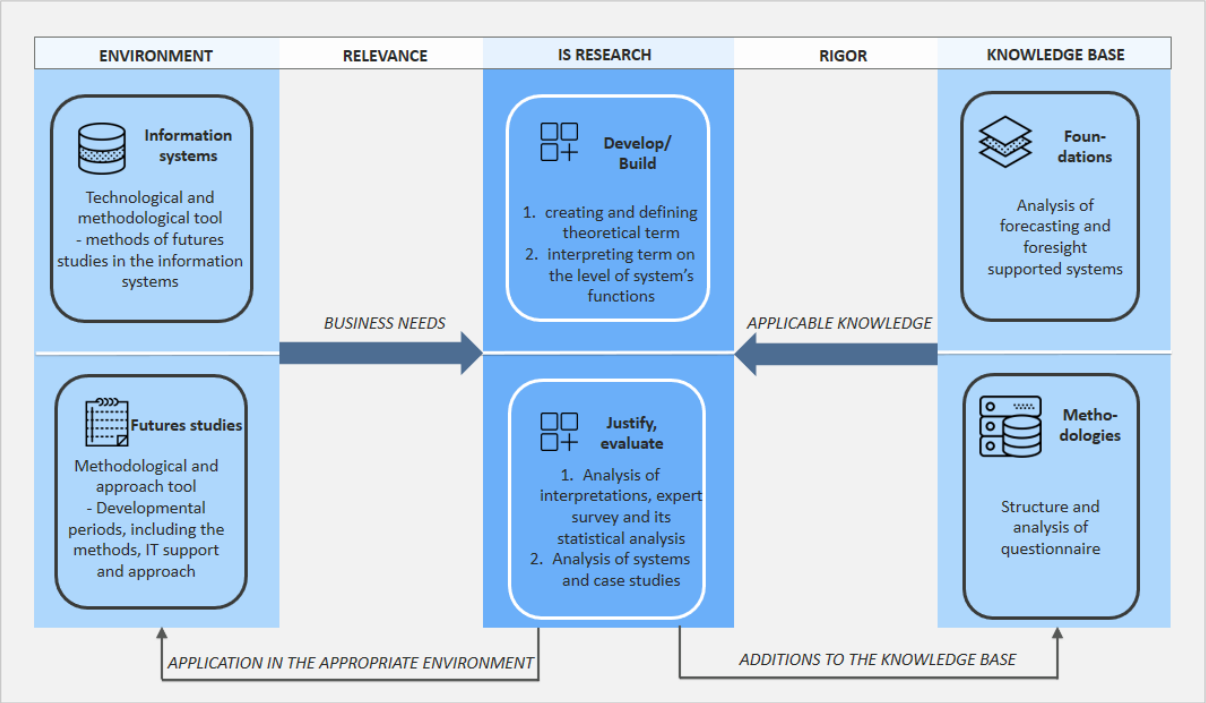
2.2. Research Concept

The presentation of the research concept is based on the logic of Hevner et al. (2004). They argued that research is determined by economic demand seeking convenience in business. Economic demand is a good reason for formulating research questions reflecting real-life problems.

My PhD thesis also serves to satisfy a business need - there is indeed growing demand on the market for the joint application of a methodological/technological means - such as information systems - and futures studies, which supports demonstration and methodology. To achieve this, it seems necessary to find evidence for the presumption that their development was organic rather than isolated, and prove that their mutual support may present a toolkit for aspects, methodology and technology that will support the user to make a

decision that exploit the quick, real-time decision support of the information system and long-term analytical techniques offered by futures studies.

FIGURE 1: RESEARCH CONCEPT



SOURCE: MY OWN EDITION BASED ON HEVNER ET AL., 2004

My paper contributes to information system research inasmuch as it highlights that such systems be used more consciously, and provides an analysis with theoretical and practical components for the sake of easier application. By presenting a historical overview of information systems and futures studies, the new intersection element of the two fields becomes apparent, which, by applying forecasting and foresight methods and relevant aspects, will broaden its range of objectives. During my research I always strived to cross-reference and interpret theoretical knowledge and practical skills. My task was to collect, group and reveal correlations that may become the basis of more thorough analytic research. The importance of a theoretical concept lies in its methods and functions being used consciously in practice, and that the knowledge of both fields may see simultaneous use.

3. RESULTS OF THE THESIS

3.1. IT Supported Futures Studies

The first research question required me to examine the information systems and IT solutions to see which futures studies methods they support and in what ways. The field to be analysed is in the intersection of futures studies and information systems, more specifically, how software are based on methods of futures studies and in what ways these methods appear in information systems. The information system as we know it today is a product of the past fifty years, and it definitely can give a boost to futures studies.

Miles and his research team defined five foresight generations according to which changes and challenges occur in the perception and practice of foresight (Miles, 2008). It must be pointed out that the methods of each generation do not replace but complete one another, build on one another and expand the methodological toolkit of futures studies. I use this study as a framework and I extend it with the estimated time period of the given generations, related methods and these supported IT solutions, as well as those features of futures studies which may have been appeared dominantly in the given period. Futures studies still has not developed to a field with standardised features which are accepted by a wider community. These features – multidisciplinarity, interdisciplinarity, transdisciplinarity, complexity, alternativity, participation, normativity, interactivity and dynamism – can of course be observed in other branches of science, however, their simultaneous appearance and use is a unique feature of futures studies.

In the 1st generation the software solutions of forecasting methods have been developed which has enabled data storing, data analysis and predicting the future These software- mainly ones relying on mathematical and statistical methods, and some others used for modeling - greatly facilitated the processing of vast amounts of data, making them easy to track, find and transform. The various software targeted different tasks, eg. preparing a plan to reach a certain goal with an array of pre-set conditions, or devising an adaptation schedule to match changes in the future. The simultaneous application of IT solutions and futures studies methods resulted in the calculability and traceability of complex systems and processes, and Futurists could finally focus on finding correlations and applicable methods instead of doing calculations and registering data.

In this period numerous foresight methods became supported by IT and were digitalised. It was the point when the objective of futures studies widened to include a search for alternatives which required defining future conditions and calculating various options

based on "if …, -then …" processes. Exploring alternative ways was aided by a range of simulation software. Qualitative methods for researching the future also started to appear (Nováky, 2004). The so-called semi-qualitative methods transform qualitative data (such as assessments and aspects) into quantitative data, based on basic mathematical principles. Semi-qualitative methods include e.g. the multi-criteria analysis (MCA), the cross-impact analysis (CIA), and the Delphi survey. Qualitative foresight methods were also developed in this period, for example scenario writing, back-casting and expert panels. The software support of qualitative methods has since been solved, however, in that period, IT support had not existed. Thus researchers had to rely on software which processed qualitative data rather well, but were of limited use when the input data was a text.

In the 3rd generation forecast and foresight were increasingly supported by IT solutions, but these solutions were designed **in a sporadic and isolated form.** Forecasting methods developed in the first era - for example time series analysis, modeling, trend extrapolation analysis - may also be considered quantitative methods of foresight, a field developed some time later. The third generation of future studies researchers applied more and more complex modeling solutions - for example, system dynamics models and macroeconomic models. Data mining and business intelligence (i.e. BI) reached a level that allowed the user to become familiar with the earlier unforeseeable correlations. The Internet made a great deal of data and interactive communication possible, however, these applications were not in widespread use back then. Researchers first became able to exploit collaborative functions in the next period.

Generation 4 not only brought along isolated forms of **IT solutions targeting the future,** but also **integrated applications** realised in various type of information systems. This integrated nature appeared in the logic the methods were built onto each other, or were embedded in one another, which offered process-level or system-level logics. User interactions generated numerous image- sound- and other files. These came to be the basis of methods for analysing large-scale data. In this era, researchers could already use data-mining and web-mining applications as well as group decision support systems. The next step was the appearance of foresight support systems ($F^{s}SS$) making use of decision supporting functions such as text mining and data visualisation.

Generation 5 was a breakthrough in comparison with generation 4 inasmuch as a stronger cooperation of IT support and futures studies resulted in more **complex, integrated solutions** by making use of **the strengths of informatics**, eg. artificial intelligence, data visualisation and business analytics. In informatics, mobile devices and broadband internet soon became

widespread, which could finally support real-time decision making. In the past few years, foresight support systems have been supplemented by **forecasting support systems** (F^cSS) (Spithourakis et al., 2015). According to Ord and Fildes (2013), the existence of such a system refers to the existence of a procedure set that facilitates the interactive forecasting of key factors in a given organisational context, and thus facilitates decision support, too. It can be stated that F^cSS is a decision support system with a target focus on forecasting. When the two system types appear simultaneously, the mix may be called a **Forecasting and Foresight Support System,** abbreviated to **F^2SS (**Spithourakis et al., 2015)**).** An important ambition is the integration of qualitative and quantitative information in foresight analyses (Karlsen, 2014), which may be helped by F^2SS. The two systems – forecasting and foresight support systems – supplement each other quite well. The combined usage of hard and soft data may generate a more accurate forecast (Song et al., 2013). The complex solutions developed at that time already relied on the combined application of forecasting and foresight methods.

TABLE 1: SUMMARY ABOUT THE IT SUPPORT OF FORESIGHT GENERATIONS

Name and time period of the generation	Challenge of the generation	In the futures studies applicable IT solutions	Features of futures studies	Level of IT support
Technology forecast 1950-'65	economic growth, energy crisis	mathematical, statistical and modelling software	multi-disciplinarity, complexity	support for forecasting methods
Technology foresight 1965-'85	environmental pollution, population growth, non-renewable resources	world models, simulation, qualitative foresight methods, scenario	inter-disciplinarity, alternativity	support for foresight methods
Social foresight 1985-2000	globalization	system dynamics, macroeconomic models, collaborative solutions	participation, normativity	sporadic-proliferation, isolated IT solutions
Political foresight 2000-2010	terrorism, sustainability, clashes between civilizations and religions	data and web mining, GDSS, machine learning, BI, DSS, F^sSS, optimization, visualization	trans-disciplinarity	increasing proliferation of integrated solutions
Stakeholder involvement in foresight 2010-	digitization, extreme uncertainty because of a turbulent environment	real time DSS, deep learning, big data, F^cSS, F^2SS	dynamism, interactivity	mutual, integrated application of informatics and futures studies

SOURCE: OWN COMPILATION; (G)DSS: (GROUP) DECISION SUPPORT SYSTEMS

The ways certain IT solutions helped futures studies methods are clearly visible in Table 1. Information systems and IT solutions originally supported forecasting methods only, by collecting, storing and analysing data and providing software solutions for forecasting. Later, a full or partial IT support of forecasting methods promoted the development of limits in time and space as well as the development of consensual solutions. Researchers have benefited from faster computer-aided data processing, shorter breaks between steps, disappearing

spatial barriers, enhanced interaction. As a result, they can now focus more on analysis. A further advantage of information technology is that the methods became embedded by a certain logic, and existing IT solutions (such as artificial intelligence, business analytics and visualisation) were used to realise futures studies targets.

3.2. The Role of Futures Studies in Information Systems

When tackling the second research question I examined the ways, elements and functions with which futures studies aspects and methods could contribute to the development of information systems. To give a name to the new information system element I coined the phrase "futureware" from the words "futures" and "ware". One result of the analysis of IT solutions that support futures studies is the futureware element becoming apparent.

Futureware is a term which means the systematization and application of forecasting and the foresight approach and methods realized in information systems. The futureware ensures complex approach which supports to take into account and synchronize the short, middle and long term objectives. The aim of futureware is to increase users' knowledge of the future; and in addition to enhance future-oriented thinking, to provide filterable information about the future, to analyse and understand the future related information, to forecast and foresee the short, middle and long-term future, furthermore to support real time decision-making. Another aim is to fulfil a reflexive and coordinating role by real time decision support.

The futureware means the functions and solutions of information systems which are applied to analyse the future. Futureware contains those functions and solutions of information systems which regard the analysis of the future. The **forecasting functions** (**S1-S7**, s: statement) of the futureware support enable the user to:

- make more grounded decision by data gathering and analysis (S1),
- make more grounded decision by automatic analysis of text sources (S2),
- make more grounded decisions by exploring hidden connections in big data (S3),
- interpret decision and its impacts visually (S4),
- interpret decision in short and middle term (S5),
- make decision according to real-time data (S6),
- make decision according to forecasting expected alternatives (S7).

With the functions presented above, futureware predominantly contributes to forecasting the expectable future and its alternatives. The **foresight functions** (**S8-S14**, s: statement) of the futurever enable the user to:

- prepare decision by identifying the unexpected events (S8),

- prepare decision by identifying new phenomena (S9),
- prepare decision by identifying innovative solutions (S10),
- develop decision by applying collaborative techniques (S11),
- interpret decision in middle and long term (S12),
- make decision in knowing interest of different stakeholder groups (S13),
- make decision in knowing alternatives what differs from data based alternative (S14).

With the above functions, futureware may best contribute to defining mid-term and long-term solutions and alternatives that are considerably different from them. Computer-aided forecasting and foresight functions complement each other and offer a solid basis to analyse the future. I find it important to highlight these functions as new concepts because they go beyond the functions of information systems that have been defined previously. The "futureware" concept goes way beyond the present functions of information system elements, because they utilise informatics and futures studies knowledge to realise forecasting and foresight targets. The forecast and foresight functions contribute to supporting decisions valid for various time periods. Furthermore, their market value is constantly rising.

The most significant methods of futureware and their importance in futures studies will be formulated below. Their software solutions and programmed functions all comprise parts of the futureware component. Such methods include[1] mathematical and statistical methods, modelling procedures, optimisation, data mining models, big data techniques, machine learning solutions, chaos calculations, semi-qualitative and qualitative foresight methods, and visualisation.

Mathematical models – including system dynamic, evolutionary, econometric and global models – help us understand correlations and logical connections between data. They can also reveal the most likely long and short-term complex future alternatives. Statistical models (e.g. time series and regression models) are suitable for analysing past and present data. They may be used for defining trends and forecasting the near and the far future. Simulation can be used for various future options. Simulating "if ..., then ..." scenarios can be used to check the impact of a certain decision and forecast a likely and an alternative future, both near and far. The target of optimisation is to define the best alternative possible, and to compare the available options. Data mining models, including web-mining and text-mining, use various statistical analytic techniques (factor analysis, neural networks etc.). They take data samples

[1] I tried to select the methods which may aid futureware in the most convenient manner. The methods do not fall into clearly distinct groups, there are overlaps.

and reveal patterns. They help us understand the present and the past back to the point the data was collected. By using large scale data techniques it has become possible to recognise hitherto unnoticed correlations and patterns. Computers may reveal parts of the future which would otherwise remain unseen to the human eye. Machine learning is a part of data mining, the solutions of which support the exploration of correlations by employing learning algorithms. A forecasting model can be prepared next to calculate future values. The target of chaos calculations in unstable situations is the forecasting of chaotic behaviour of non-linear systems, the identification of development paths that are qualitatively different from the present, and, finally, the calculation of alternatives deviating from a likely future. Semi-qualitative foresight methods – e.g. Multi-criteria analysis (MCA), cross-impact analysis (CIA) and Delphi surveying – help us with defining future phenomena that differ from those of the past so that we may gain access to the far future. Qualitative foresight methods – e.g. scenario writing, backcasting, expert panels – have the target of exploring a creative and innovative future in a longer term. These methods support the entire process of foresight, but fail to define a likely future in figures. Visualisation makes it possible to display data visually and thus supports an easier and deeper understanding.

I shall examine futureware in the context of the system and also in relation to embedded systemic elements. **The elements of the information system adhere to one another closely and form a complete system.** In the course of the development of information systems there were developmental periods to be defined below.

ITC system elements fall into four larger periods (table 2.) Each period embraces 15-20 years. Every period built on the skills of the earlier one and the components utilised the others. We should note that the emergence of one component enabled the development of another. More connection points and causal relationships can be observed among components while developmental periods are outlined in time.

The evidence suggests that the function of each element is built on one another. The data transforming and processing function of **software** could not operate without the data storing function of **hardware**. The data organizing and controlling role of **dataware** and the data delivery function of **netware** are essential in respect to IS. The functions of **futureware** strive to utilize every function of information systems to analyse the future. Information systems can work without futureware but futureware increases the purposes and value of IS.

In terms of **areas of application**, in the first period the mainframes are used in nuclear energy research laboratories and in the military industry, at that time governmental institutions, companies and banks used to run the business critical applications. In the second period

emergent personal computers provided the individual use of information systems not only for organizations but also for individuals. In the third period more and more people became involved in the digital world and small and medium enterprises increasingly focused on the online appearance, sales and services.

TABLE 2: PERIODS OF DEVELOPMENT OT INFORMATION SYSTEMS COMPONENTS,

-WARE[2]	**1st period 1955-1970**	**2nd period 1965-1980**	**3rd period 1975-2000**	**4th period 2000-**
HARD	mainframe	mini and PC	ICT tools	ubiquitous computing, Internet of things
SOFT	electronic data processing, transaction processing system, management information system	(group) decision system, executive information system, expert system	enterprise resources planning, business intelligence	enterprise performance systems, business Suite
FUTURE (part of the SOFT)	statistical, modelling software, simulations and forecasting software	foresight software	participatory IT solutions, data and web mining	forecasting and foresight support systems (F^2SS), business intelligence (BI), artificial intelligence (AI)
ORG	appearing standards, architecture design by specification	declining standardization, architecture design by products of manufacturers	cloud-based computing, service oriented architecture, architecture design by integration and service	platform independent architecture design
NET	synchronization of components of information systems	analog voice (1G)	digital voice (2G), global solutions (2,5G)	broadband (3G), IP based bandwidth (4G)

SOURCE: OWN COMPILATION

A plethora of potential application fields appeared in period 4. It is enough to mention two generic terms, internet of things and ubiquitous computing, to demonstrate its growing circle of use.

Futureware appeared in the first three periods only sporadically. It was not until period 4 that futureware turned into an indispensable element of complex management in economic, social, environmental and other matters where the involvement of those concerned was unavoidable or many aspects had to be considered simultaneously in order to make future alternatives contribute to making the right decision. **Futureware can be used to forecast or to foresee, which makes it a key element of smart solutions.** Futureware helps users to achieve their aims by utilizing functions of all the other elements (hard-, soft-, org-, net-, dataware) in order to gain the analytical potential concerning present and future.

[2] The analysis of dataware is not included in the table since no development periods can be linked to the dataware element. The elements of software are narrowed down into the field of decision support in the table.

I conducted a survey to examine the futureware concept in business life. The average respondent (n=103) fully or generally agreed with statements concerning forecasting and foresight functions. The **necessity of the futureware component** was only rejected by 5%, while 10% did not answer. **All the other respondents generally or fully agreed. Separating futureware** as an individual information system component triggered the same reactions as the question about the necessity of futureware; however, the rate of negative answers was 5% more. Concerning the **reason for separating the futureware component** respondents could choose more than one option. The three most popular were: (1) they not only support short-term decision making, but mid- and long-term decision making too, (2) they are key in decision making (3) their use is an important element of creating competitive advantage. Individuals who rejected the separation of the futureware component usually opted for the reason that user decisions are already adequately supported without separating the forecasting and foresight functions.

The sample was then reduced to contain only those with knowledge of information technology and futures studies (who perform forecasting or foresight tasks at least once every 2-3 years and use relevant IT solutions). The sample was reduced to contain 47 elements; this cleaned sample retained the proportions with regard to residence and qualifications.

Daily users of BI solutions generally gave the most positive answers to forecasting functions. **All BI users generally agreed with the statements defining forecasting functions.** The existence of two functions were praised by most: forecasting solutions become more grounded if hidden correlations are revealed and data is analysed. Real-time decision making support function was the source of the most divergent answers, with a smaller proportion of respondents (25%) disagreeing with the statement.

Half of the experts use foresight support systems ($F^{S}SS$) and collective intelligence systems, while the other half either use such systems or at least have theoretical knowledge about them. **It may be concluded that the respondents generally or fully agreed with the separation of forecasting and foresight functions as an individual information system component.** Responses also outline the pattern that the more often respondents used information systems to prepare foresights, the more strongly they agreed with the separation of forecasting and foresight functions as an individual component.

Based on the answers regarding foresight support system use and foresight function values we may say that users who work with such systems daily were the most positive about foresight functions. **Results show that a significant percentage (~75%) of experts generally or fully**

acknowledged the forecasting functions. 10% did not agree with the statement that foresight functions support users in making decisions when they are aware of alternatives.

Four clusters were separated in the process of clustering. The first cluster (n=16) was the one which acknowledged the decision support role of foresight functions the least, and barely perceived the role of futureware. Compared to all the other groups, the first cluster hardly ever used analytical solutions, foresight support and collective intelligence systems.

Group two (n=10) generally accepted statements regarding functions of data-based forecasting methods. They also tended to accept the support and necessity of foresight functions. The second cluster is characterised by regular users, preparing forecasts and foresight on a daily, weekly or monthly basis mostly for periods of 1 year or 1-2 years.

Group 3 (n=16) supports the separation of the futureware component and acknowledges its role as a decision support. The cluster consists of practical and theoretical experts of similar quality. The members of this cluster often prepare forecasts and foresights for shorter and longer periods.

Group four (n=5) acknowledged the important role of forecasting functions even without having experienced real time data analysis and data visualisation. The members of this cluster do not use analytical business solutions on a daily, weekly or monthly basis. They generally prepare forecasts for periods of more than one year. Presumably, immediate decision support is not a task of this cluster. Cluster analysis shows that there may be a correlation between the cluster's usage of the information system and the acceptance of futureware statements. The more the respondents used software to prepare forecasts or foresights, the more they accepted the statements concerning the forecast/foresight functions of futureware.

Future studies appears in information systems via futureware, which comprises of statistical, modeling, simulation and forecasting software, participatory IT solutions, data mining and web mining solutions as well as FSS, BI and AI solutions. **Futureware contributes to an increased functionality of information systems with forecasting (S1-S7) and foresight (S8-S14) functions.** These functions have become integral elements of smart solutions. **It has multiple uses**, it appears for instance, to varying intensity, in a range of fields from predictive analytical functions of software to decision support systems encompassing full complex forecasting and foresight. **The questionnaire survey confirmed that respondents agree or strongly agree that forecast/foresight functions should be separated as information system elements.**

3.3. The Appearance of Futures Studies in Decision Support Systems

Based on the third research question, the focus of examination should be to see the functions through which forecasting and foresight support systems create an added value to decision support.

I have performed analysis on F^{2}SS modules with its main functions and placed them into a process structure to interpret the decision supporting functions of futureware in practice – comparison with theory was thus enabled. Many F^{2}SS solutions have been realised, but since most of them cost money, giving a concise overview would be impossible. Literature defining the modules and functions of the systems started to spread in the 2010s. I only analysed works examining the modules, functions and process logics of F^{2}SS (Durst et al., 2015; Keller et al., 2015; Rohrbeck et al., 2015; von der Gracht et al., 2015; Glenn, 2015). Finally, I shall attempt to make a synthesis of their findings. In the course of my synthesis the goals were to give an overview of the system modules, with their names and descriptions; to make a list of the system functions with regard to the main functions of the modules; to place the modules and their functions in the process logic of foresight; to examine how decision support and business intelligence solutions can complete and support the functions of forecasting and foresight support systems; and to reveal correlations between functions, process logic and decision supporting system types.

The co-occurrence of information systems and futures studies in decision support is mainly realised by F^{2}SS. **F^{2}SS supports futureware forecast and foresight functions with following ways** to secure short-term, mid-term and long-term decisions. F^{2}SS functions support decision management with project management and method configuration. The functions support the acquisition of information necessary for making decisions by collecting sources, building project, trend and factor databases and performing targeted searches in the Internet. F^{2}SS functions support analyses necessary for making decisions by operating forecasting markets, running statistical analyses, making forecasts, analysing user actions and maintaining inter-user communication. Interpretation of the impacts of decisions is achieved by electronic Delphi surveying, maintaining community networks and managing documents. Future alternatives as decision options are prepared by functions organising workshops, writing scenarios, enabling simpler planning, quicker analysis and consensual solutions. Functions support the evaluation of decisions by formulating criteria and using these for assessment, and by coordinating and analysing group opinions. The analysis of system functions outlines the added value: forecasting and foresight targets can be realised by the

joint application of informatics and futures studies. **In the ways listed above, F^{2}SS functions generate an added value to decision support systems.**

3.4. Summary of Research Contributions

Some results of this thesis are as follows:

1. analysis and summary of IT support of forecast and foresight methods in the development stages of futures studies;
2. creation and definition of the "futureware" concept, its placement in information systems;
3. presentation of the functions through which futures studies aspects and methodologies can influence the development of information systems;
4. practical research of "futureware" with questionnaire surveys;
5. analysis of the "futureware" concept functions in forecasting and foresight supported systems and defining their support with decision support and business intelligence solutions.

My research managed to find answers to the research questions via a theoretical and practical relation analysis, and revealed a closer relation between the two science branches.

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