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A Multidimensional Model of web-induced Flexibility in Organisations *Marc*

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Abstract

Mechanisms for controlling and regulating business flexibility are no longer limited to adjusting the number of pieces or changing item output in production processes. Information infrastructures, systems and web technologies have become an important factor for flexible business alignment: The company's scope of action comes along with communication and collaboration among their partners. This paper examines flexibility impacts of new forms of ICT (information and communication technology) on daily business use, e.g. flexibility through social virtual platforms, blogs, wikis and other emerging web-based techniques. A model of flexibility for web-based communication and collaboration in a company's context is introduced to address technical, organisational, operational, legal and social impacts of flexibility. For each aspect specific key indicators are analysed and their practicability verified by expert interviews. As an outcome an index for determining the level of web-induced flexibility for enterprises is presented.

Introduction

No doubt – the usage of the term flexibility is manifold. Very easily the picture of trees, facing environmental conditions like snow and wind, comes to mind where their adaption can be more or less easily calculated knowing their physical variables. However, detecting and gathering all relevant flexibility aspects in the context of enterprises are much more complex and multidimensional – in fact it looks like a long-term ambition for economic researchers.

First serious approaches of flexibility were already presented in the early 20th century. They have been developed further up to now, where mechanism for controlling and regulating business flexibility are no longer limited to adjusting number of pieces or changing item output in production processes or matching the labour market to the production variety or quantity. Information infrastructures, systems and technologies – as well as "state of the art" web technologies in particular – have become an important factor for flexible business alignment: the company's adaptable scope of action comes along with comprehensive communication and collaboration among their (internal and external) partners.

Different communication channels like blogs, wikis, podcasts, social virtual networks or new forms of software providing offer employees more freedom of interaction, self-organisation of processes or personal development. As the inner cell structure of a tree is responsible for its elasticity, as the inner structure and operational sequences constitute the level of business flexibility.

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On this basis the following approach examines flexibility impacts of new (or modern) and web-based forms of information and communication technology (ICT) on daily business use. This research combines practical and theoretical knowledge and finally presents measurement guidelines for web-induced flexibility.

Five dimensions of web-induced flexibility

The main challenge in this approach is in finding the essential components and critical aspects for measuring web-induced flexibility. For lack of having a usable and commonly accepted framework at hand we develop a new flexibility model in consideration of companies' demands and closely with experiences from the practice.

Our first supposition came out of literature studies and practical experience, so we considered the impacts of web-induced flexibility in four business dimensions – the organisational, operational, technological and legal perspective. Semi-structured interviews with executive managers of IT companies/departments confirmed our perception but also confirmed our intuition that we need a fifth dimension, the social perspective.

Developing an index which covers all relevant facets in a business context makes it necessary to categorize each dimension and split it into several focal points, where web technologies can unfold their potential and should be measured by special key flexibility indicators (KFIs). A first hint where these potentials and effects come up can be given by answering the questions of which parts and activities of Porter's value chain are affected and in which extent flexibility by new web technologies is evoked. In the outcome we extracted 16 categories along the five mentioned dimensions of web-induced flexibility. In the following, a short specification of the dimensions and focuses will be given.

The organisational perspective

Under the organisational perspective we summarise those components related to web-induced flexibility which have effects on the institutional side of organisations and their structure. From our point of view we see flexibility aspects shaped by five focal points.

Vision, business objectives and culture: Transformation processes are mostly attended by the ability of adapting visions, business objectives or culture to environmental influences. Also technological systems are not independently deployed but rather embedded into a set of "invisible" attitudes which are part of the inner company's structure and facilitate their acceptance and success. Even if these factors are rarely easy to put into numbers those KFIs are essential to consider.

Business strategies: The strategies and business plans set by the executive board are closely connected to the economic visions and goals. Accordingly, an organisation-wide implementation of modern web ICT closely depends on the motivation and readiness of managers to rethink communication and collaboration processes. Special KFIs should take this fact into account.

Budget and finances: The assessment of measures is an organisation-wide element of overall importance. Any expenses incurred for setup and implementation, usage and operation of modern web technologies will be calculated and used for effectiveness argumentation or project control. Financial KFIs will meet these concerns.

Organisational structure: The configuration of a company organisation structure may be a key factor for the ability to align employees and processes they are involved in to changing demands and external influences. Often there is a lack of flexibility in traditional, hierarchically structured forms due to a system promoting to work according to instructions. On the contrary modern

structures are aiming to give a basis for self-organisation and customer-oriented processes. KFIs shall focus on the evaluation of the potentials arising from using modern web-based technologies.

Corporate leadership: Modern principles of leadership are encouraging the individual potential and a self-responsible, participative integration into operating processes. Flexibility impacts due to modern web technologies may be assumed to be promoted by those managers who are highly supporting these principles. Leadership oriented KFIs are determining disciplinarians' attitude.

The operational perspective

The operational dimension focuses on a process-oriented organisation where labour is allocated by task analysis and synthesis into complex business processes. This view also considers the labour relations consisting of a permanent negotiation of employer's and employee's positions. Impacts on flexibility due to the use of web-based technologies of communication and collaboration appear in particular on these business processes and job activities. From our viewpoint implications can mainly be seen for two work related issues.

Work conditions, time and adaption: Numerous influences of the past decades have changed work related elements, like contracts, workings hours and the integration of family or satisfaction in the job – in short: the comprehension and personal value of employment seems to become flexible as well. Obviously KFIs for modern web technologies are difficult to define – however this fact must not be ignored and should be found in an extensive flexibility index.

Procedural work integration: This focal point takes account of business flexibility by adjustable processes, namely the support of elementary processes, sub processes and complex business processes by modern web-based ICT. It seems more necessary than ever to realize that changes should not be avoided but ought to be seen as an elemental part of commerce. KFIs are monitoring the integration of web-based technologies in these processes.

The technological perspective

Besides all other perspectives a framework for measuring web-induced flexibility has to consider the aspects of modern web technologies by extracting adequate KFIs very carefully. No doubt, the technological scope may be varying between enterprises and must also be adjusted over time. Therefore a classification into five focal categories is proposed.

Infrastructure and development: Under this point we summarise all flexibility indicators with a focus on a company's web infrastructure. From a practical point of view it seems to be helpful to get the infrastructural preparedness for modern ICT. This point also includes the general web-based alignment of the IT department.

Cooperation and collaboration: In our comprehension – and according to views of different others, like [PDM 2011] or [FRS 2011] – modern ICT in enterprises mainly consists of the usage of weblogs, micro blogs, wikis or podcasts which we perceive as cooperative services. Each of them makes a contribution to the web-induced flexibility by its own characteristics and unique attributes. The KFIs should meet these technology tailored concerns.

Virtual social networking: Another significant technology, enterprises are going to implement company-wide is the implementation and usage of web-based social networks. In our comprehension networking exceeds cooperation and collaboration between colleagues by the job content which is individually transferred to the virtual space. In fact these virtual networks represent the collective procedural knowledge and constitute the space for flexible process configuration or job handling what should be highlighted by specific KFIs.

Combination of services: The technological combination of different services through so-called mashups is an upcoming trend which should be reflected in the proposition of measuring web-induced flexibility. The use of technical web standards and the openness of web-based interfaces enable services of different functionality and ownership to open up and present enhanced information to the customers. Even if O'Reilly pointed out this power of new web technologies more than 10 years ago, companies are still in a state of trial.

Data privacy and security: One of the most mentioned difficulties (e.g. see [FRS 2011], [SYM 2011]) for successful implementation and company-wide use is the uncertainty of handling with privacy and security issues. KFIs are useful to detect obstacles and find limitations of web-induced flexibility.

Social perspective

Out of our experience the social factor is still an underestimated influencing variable when looking at technologies in general, but especially for ICT in enterprises (what is surprisingly even though it is constitutive for the principles of Web 2.0). We categorise this dimension into the personal and the more general socio-personal field.

Personal issues: Humans are the centre of attention in modern communication and collaboration technologies. In this respect KFIs need to measure the direct dependency of web technologies on flexibility aspects which are allocatable to personal factors.

Socio-personal issues: In our point of view it is necessary to broaden the personal perspective and represent the social relationship between employees, shareholders, management and customers in modern communicative web technologies.

Legal perspective

One of the most discussed obstacles for an enterprise-wide use of modern web technologies and its importance have brought us to another separate and final dimension. Against the background of flexibility the design of legal issues constitute this framework by contractual and lawful aspects.

Contractual issues: Observing the law of contract – if purchasing e.g. web-based services or capacities from external service providers – can be seen as a basic requirement for web-induced flexibility. The same applies to departments inside the company where agreements for service delivery are concluded. Contract focussing KFIs gather and identify the legal scope where flexibility can develop.

Lawful issues: At first glance legal compliance may be experienced as a limiting factor for flexibility in general, and especially if considering the regulatory mechanism of lawful issues in web-centred data handling. Belonging KFIs are going to measure these limiting lawful influences for web technology usage in enterprises.

Along these five perspectives with 16 focal points flexibility indicators have to be developed and merged to a measurement index followed by a particular construction scheme.

Conceptually Designing a Flexibility Index

In general an index is generated by a combination of characteristic key indicators or variables standing in a special relationship to the interesting matter (see e.g. [BOD 2006, p. 143 f.]). Looking at a single variable often insufficiently examines the complex situation. As Kaplan/ Norton (see [KAN 1996, p. 1]) illustrate in their well-known introducing example of measuring business strategy, a single orientation on e.g. "air speed" instruments are not sufficient while

the carefully chosen set of different parameters empowers the pilot crew to perform a controlled flight. Similar to this plain example our model's goal is to provide a further and enhanced view for IT analysts, IT management and controllers managing new communicative web technologies.

Necessary basic information

Several requirements for gathering these KFIs facilitate the content and orientation of the indicators. First criterion is in meeting specific conditions, which means that the index shall contain indicators measuring the level of preparation of the environment in which web technologies are applied. Secondly, the indicators should point out the implications as well as the transparent benefits and advantages along the considered technologies. The third criterion concentrates on valuating the costs related to implementation and using web technologies.

Here costs contain mainly monetary elements but also include personal expenditures and time investments. The fourth condition for developing these parameters is in measuring web technology-immanent properties.

1. What is the purpose of this measure?
2. What is the scope of this measure?
3. What attribute are we trying to measure?
4. What is the natural scale of the attribute we are trying to measure?
5. What is the natural variability of the attribute?
6. What is the metric (the function that assigns a value to the attribute)? What measuring instrument do we use to perform the measurement?
7. What is the natural scale for this metric?
8. What is the natural variability of readings from this instrument?
9. What is the relationship of the attribute to the metric value?
10. What are the natural and foreseeable side effects of using this instrument?

Figure 1: Evaluation Framework (see [KAB 2004])

Developing a framework of web-induced flexibility

Besides these general requirements we follow a more concrete procedure of flexibility indicator development in our approach. Therefore we refer to the evaluation framework which Kaner/Bond (see [KAB 2004]; [HOF 2000]) recommend for establishing measurement systems (see Fig. 1). With this knowledge we build a special form where the flexibility indicators will fit in (see Fig. 2).

For referencing purposes it basically consists of the fields "*Main focus*", which describes the related focus of a dimension, further an "*Indicator name*" and a unique "*ID*", followed by the main part which includes more detailed information. "*Description*" delivers the content of what is measured and on which criteria the flexibility indicator is based on. "*Metric*" may display the specific outcome and the kind of the indicator's result, e.g. rational, numerical, monetary, time or nominal. The field "*Consequences for flexibility*" points out the connection between web-induced flexibility and this indicator, why it contributes to the goal of measuring flexibility and why it needs to be investigated.

Especially in bigger enterprises it seems to be helpful to know a responsible position (or role) that is mainly involved in consolidating the indicator's criteria – this information can be kept in the field "*Responsibility*". Special "*Dependencies*" which can affect the result are enumerated in

the field of the same title. Here, all relevant information, e.g. specifications of software assets or hints of gathered information in other departments, can be published. In contrast, the field "*Relation*" subsume essential interaction with other indicators (e.g. their IDs). Mostly it is of an interpretative or calculated (computed) manner. A relation can be seen as interpretative if logical implications arise through the meaningful combination of their results, while it is computed if all influencing values necessarily exist. Finally a practical striking example can be given which describes the indicator in a business context.

	Main focus ***Indicator name*** **ID**
Description **Metric** **Consequences for flexibility** **Responsibility** **Dependencies** **Relation (I/C)** ***Example***	

Figure 2: Flexibility Indicator Framework

This given flexibility indicator framework is intended to be seen as a vantage point for building the web-induced flexibility index. The final index metric results from the measured values of the combined indicators and is computed for each single dimension (perspective). Caused by the heterogeneous metrics the indicators may have, we suggest – besides the already mentioned metric – a standardising conversion by a rating scale representing the indicator's contribution to a company's flexibility. For instance we decide on an easy to handle scale with items from -3 to +3: in our comprehension we interpret the value "-3" as no result, a "0" as pending and a value of "+3" as optimal contribution for web-induced business flexibility. A detailed interpretation is presented in figure 3.

According to our practical findings the quality of the step of conversion can be on high level with marginal variances if a few number of company's experts with a broad technical and organisational background are involved in this process. An additional step integrates the index importance (weight) of an indicator's outcome. So the index number of a dimension results from its weighted metrics of the chosen flexibility indicators.

Level of flexibility	Contribution to flexibility	Interpretation
-3	Outcome is of no account for web-induced flexibility	No flexibility, situation analysis may be recommended
-2	Outcome is of no significant account yet	Modern ICT is in planning phase or already in isolated use in small groups for beta testing
-1	Outcome implies a sporadic and regional limited web-induced flexibility	Planning phase is completed, conclusions and "lessons learned" are pending
0	Average, outcome has positive influences in parts	Potential is realised by IT management, but ambitious realisation of modern ICT is pending, further internal studies necessary
+1	Outcome contributes to web-induced flexibility but comparatively not as significantly good	Broad realisation of flexibility impacts by modern ICT on management level, further use is assured
+2	Significantly good contribution and diffusion in numerous departments	Potential of ICT is visible in all focal points, continue usage and promotion
+3	Exceedingly contribution and widespread on company level	Using modern ICT in an optimum way

Fig. 3: Exemplary interpretation of the rating scale from -3 to +3

Key flexibility indicators for 16 focal points

Out of the preliminary work approximately 100 flexibility indicators along these five dimensions respectively 16 focal points were extracted – a huge and almost unmanageable amount of surveying parameters in practice (not to mention the immense personnel costs for gathering the required information). Practice itself may be an appropriate partner and a way of resolving these conflicts. Moreover quality of the index can be increased by obtaining the most practical and popular flexibility indicators.

Therefore 10 experts from international acting enterprises having experiences in modern web-based ICT services were consulted. As a condition we selected the experts by their knowledge and managerial position which enables them to oversee all five dimensions and allow a professional review. The interesting aim of each interview is to get a statement to the *importance of the focal points*, the *importance of their dedicated flexibility indicators* and their *anticipated costs of evaluation*.1 In addition further relevant indicators should be mentioned if applicable. The used questionnaire can be found in appendix A1.

An analysis of the statements made in this expert interview provides the opportunity to sort indicators by popularity so there will be a meaningful index extracted at the end. The experts mentioned that all 16 focal points are of quite high relevance for them (see appendix A2), but the dedicated 100 indicators are not easy to handle and probably associated with huge costs.

The degree of popularity for a specific indicator is defined by the importance of its related focal point, its own importance and its anticipated costs.2 In order to reduce the amount of indicators we choose the two most popular indicators of a focal point and include those additional indicators which are mentioned by at least two experts. The instrument of evaluating web-induced flexibility regarding a balanced view on all dimensions can be specified as follows.

Dim.	Focal point	Description	Metric
Organisational	Vision, business objectives and culture	Ability of corporate culture to adapt to changes (e.g. via suitable employee selection, willingness to have innovative processes/services)	O
		Importance of people orientation in processes of goods and services	O
	Business strategies	Ratio of integrated/used modern ICT in business segments	R
		Estimated ratio of integrating modern ICT in future business segments	R
		Affinity of executive board using web-based ICT for communication and collaboration within the organisation	O
	Budget and finances	Comparison of overall costs of traditional and modern technologies	M
		Cost savings due to modern web-based ICT	M
	Organisational structure	Degree of vertical bureaucratisation (e.g. communication between managers and employees, communication between employees)	R
		Relation of management positions to executing positions	R

[1] A pretest reduces the amount of indicators which are going to be commentated. Indicators associated with high costs of evaluation are omitted. During the interview the interviewee may fall back to them if applicable – so if more than 5 interviewees make a statement the indicator is included into the counting.

[2] The used transformation of the questionnaire into a metric for popularity is by a multiplication of its single values.

		Degree of formalisation at project level (e.g. conflict between space and formal construct in project)	R
	Corporate leadership	Employee centred number of events motivating and boosting web-based ICT usage	A
		Manager centred number of events motivating and boosting web-based ICT usage	A
Operational	Work conditions, time and adaption	Personal utilisability of implemented modern ICT (e.g. handiness, expandibility, connectivity, structurability)	O
		Personal review of temporal and areal mobility in colleagues' work environment	O
		Finding physiological aspects regarding web-induced flexibility (e.g. stress, mental flexibility)	O
		Time spend in using modern ICT (e.g. split by technology)	T
	Procedural work integration	Proportion of modern ICT used at an entire business process	R
		Execution time for a complete business process	T
		Estimation of potential for flexibility possible on elementary process level	R
		Estimation of potential for flexibility possible on sub process level	R
Technological	Infrastructure and development	Relation of used web service technology to entire infrastructure	R
		Proportion of IT projects regarding modern ICT to overall IT projects	R
		Proportion of Cloud-PaaS on entire development infrastructure	R
		Proportion of Cloud-SaaS on entire software providing	R
	Cooperation and collaboration	Proportion of employees participating in cooperative services (e.g. blogging employees)	R
		Proportion of cooperative services for corporate communications to overall communication processes (e.g. separated into internal and extern communication)	R
	Virtual social networking	Proportion of employees participating in virtual corporate network	R
		Proportion of user profiles' actuality	R
	Combination of services	Number and proportion of mashups used in a business process	A/R
		Number and proportion of externally provided parts of mashups used in the IT department for service providing	A/R
	Data privacy and security	Average time period of service outage	T
		Number and proportion of service outage	A/R
Social	Personal issues	Proportion of active to inactive employees	R
		Overall expenses for employee trainings related to modern ICT use	M
	Socio-personal issues	Quality of relations among colleagues explored through an evaluation	O
		Importance of work related advancements and social skills through corporate programmes increasing social-personal flexibility	O
Legal	Contractual issues	Level of fixedness caused by contracted elements (e.g. contract period, flexibility of integral parts of contract)	O
		Integration of other index values related to quality of services (e.g. consolidation of essential indicators form ITIL framework)	O
	Lawful issues	Ratio of consultations of works council on decisions related to modern ICT to overall decisions	R
		Implementation, operation and development of modern ICT in accordance with privacy policy (e.g. number of infringements)	N
Values: M = monetary A = absolute T = time O = ordinal/rating scale R = ratio			

Fig. 4: Key Flexibility Index as an instrument with 40 indicators

Conclusion and prospects

The 40 indicators constitute an aggregation of ease and expressiveness and may be qualified to measure web-induced flexibility. Especially the multidimensional perspective may be seen as a necessary approach to enlarge a view which is predominantly focused on technology. Practice attests that differentiation in so called focal points can be helpful to identify flexibility potential or allocate weak spots with their optimisation. Nevertheless the presented index should not be understood as complete. We do not see it as a fixed and hardly adaptable model, rather it should be flexible itself – therefore it represents an approach that takes flexibility into account when establishing or tuning indicators in organisations. The index offers assistance to decision makers summarising pros and cons for technical service orientation, especially for the corporate use of blogs, wikis, virtual networks or cloud services.

One part of future work will be closely combined with practical results and the practical handling of the model as reported back by enterprises. It will be necessary to improve the model's benefit through an optimally chosen (i.e. cheapest and with most informative value) set of flexibility indicators. Therefore correlations between costs and benefits must be determined more precisely. Another part of future work is to look out and potentially add other aspects to the multidimensional model such as to deepen existing focal points with KFIs. Especially the legal perspective is currently diversifying its components to a market- and customer-compliant demand. Finally, intuitive assessments of flexibility made by managers will be compared with the results obtained by the multidimensional model. Converging and diverging results will be studied.

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Appendix

A1. Questionnaire

1.	From your practical experience, how important is this focal point for the purpose of measuring web-induced flexibility? The inclusion of this focal point is … important (1). / … of average importance (2). / … not important (3). / … no idea (-).
2.	From your practical experience, how important is this flexibility indicator for the purpose of measuring web-induced flexibility? The inclusion of this KFI is … important (1). / … of average importance (2). / … not important (3). / … no idea (-).
3.	What would you like to comment about this specific indicator?
4.	The costs of evaluation for this flexibility indicator are presumably … little (1). / … on average (2). / … high (3). / … no idea (-).
5.	From your practical experience, which further KFIs should be added to this focal point?

A2. Importance of focal points

Organisational dimension

Focal point	Average relevance
Vision, business objectives and culture	*1,2*
Business strategies	*1,3*
Budget and finances	*1,4*
Organisational structure	*1,4*
Corporate leadership	*1,3*

Operational dimension

Focal point	Average relevance
Work conditions, time and adaption	*1,2*
Procedural work integration	*1,2*

Technological dimension

Focal point	Average relevance
Infrastructure and development	*1,3*
Cooperation and collaboration	*1,2*
Virtual social networking	*1,3*
Combination of services	*1,4*
Data privacy and security	*1,1*

Social dimension

Focal point	Average relevance
Personal issues	*1,1*
Socio-personal issues	*1,2*

Legal dimension

Focal point	Average relevance
Contractual issues	*1,2*
Lawful issues	*1,3*