

AN INVESTIGATION OF THE QUANTITATIVE APPROACH TO MEASURE DYNAMIC SUPPLIER CHAIN PERFORMANCE

KVANTITATIVNA METODE ZA MERENJE EFEKTIVNOSTI DINAMIČNOG LANCA DOBAVLJAČA

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Abstract: Industrial companies must daily make strategic decisions between own production and outsourcing. In wider range large industrial companies have come in front of the new challenges. Over saturated markets - among other things - in service offering often leads into ever growing subcontracting relationships. This means companies need to seek flexible and more effective ways of managing outer-firm supplier networks. This investigation gives potential way for flexible measurement system of performance in dynamic supplier networks. We examine factors affecting performance attributes and its measurement by analytical tools in outsourcing based environment. We stress the investigation to produce accurate data for determining right measures and finally for accomplishing operative system for supplier performance measurement.

Key words: analytical hierarchy process, supplier network, performance, supplier matrix

Apstrakt: Industrijske kompanije dnevno donose strateške odluke o tome da li će u procesu proizvodnje i pružanja usluga koristiti sopstvene ili spoljašnje resurse. Šire gledano velike industrijske kompanije nalaze se pred novim izazovima. Prezasićenost tržišta, između ostalog, velika ponuda uslužnog sektora često vodi u sve kompleksnije podugovaračke odnose. To znači da kompanija mora truditi za fleksibilnim i efikasnijim načinima za upravljanje mrežom podugovarača koji posluju izvan njenih okvira. Ovo istraživanje predlaže metode za primenu fleksibilnog sistema merenja efektivnosti dinamične dobavljačke mreže. Razmatraju se faktori koji utiču na osnovne atribute efektivnosti i merenje primenom analitičkih metoda u uslovima korišćenja spoljašnjih resursa. Osnovni cilj istraživanja je obezbeđivanje preciznih podataka na osnovu kojih će se ustanoviti adekvatne mere jedinice i konačno uvođenje operativnog sistema za merenje efiksnosti dobavljača.

ključne reči: postupak analitičke hijerarhije, mreža dobavljača, efektivnost, matrica dobavljača

1 INTRODUCTION

This study was taken place in high volume process industry. Moreover the maintenance function and its internal and outer supplier networks were studied.

The meaning of maintenance functions is emphasized in process industry. Interference in one

1 UVOD

Ova analiza obuhvata procese u visoko produktivnoj industriji. Osim toga, razmatrana je i funkcija održavanja njenih unutrašnjih i spoljašnjih dobavljačkih mreža.

Značaj održavanja naglašen je u procesnoj industriji, s obzirom na to da se smetnje u jednoj fazi

step of the process takes an effect through the whole process chain and costs are enormous. This means the whole chain – all the way from the suppliers to own final processes – must function with principle of JOT (=just on time). Process breakdowns are often very expensive.

When the magnitude of suppliers is increasing and own resources for co-ordinating stays approximately the same there becomes a need for performance measurement. Without measuring the right things with right tools networks have a urgent need for developing themselves in an unprofitable course.

There have been many attempts to measure supplier networks. For example Balanced scorecard, Smart, PMQ, which are mainly focused on measuring qualitative concepts [1]. This investigation takes whole new starting point for performance measurement. It gives ideas through the whole measurement process starting for finding the right measures. Furthermore it takes mainly quantitative approach for finding the right performance factors and measuring it.

Next pages will discuss the examination in nutshell. It breaks the whole study in most important phases and shows the mainstream of the study. Some of the theoretical parts are left aside assuming enlightened in the area of supplier performance measurement.

2 NETWORKING AS PHENOMENON

Networking has its share in every business strategy nowadays. Networks are established when enterprises work together producing added value in their operations. There are many definitions in literature of networking [2],[3],[4]. For Möller and Wilson [5] it means interchange and interaction between companies. In context of financial enterprises networking it's a mixture of competition as in market place and collaboration as in hierarchy.

In enterprise level networking can be illustrated by dividing different network manners in three classes [6]:

1. Horizontal networking that's collaboration between enterprises, which operate in the same line of business, and in the same phase of the value chain.
2. Vertical networking that's collaboration in the same line of business and successive value chain.

procesa odražavaju na čitav proces i stvaraju ogromne troškove. To znači da ceo proizvodni lanac - od dobavljača do sopstvenih finalnih procesa - mora funkcionisati po principu JOT/TNV (tačno na vreme). Svaki prekid u odvijanju procesa je izuzetno skup.

Kada se broj dobavljača povećava, a sopstveni resursi pomoću kojih se vrši koordinacija njihovog rada ostaju približno isti, nastaje potreba da, njihova efektivnost nekako izmeri. Bez procene i izračunavanja određenih karakteristika uz pomoć odgovarajućih mernih jedinica pomenute mreže dobavljača imaju tendenciju da se razvijaju preko granice profitabilnosti.

Bilo je mnogo pokušaja da se izmeri finkcionisanje i efektivnost dobavljačke mreže. Na primer, korišćene su metode kao što su Bilansna kartica, Smart, PMQ, koje su, uglavnom, orijentisane na merenje kvalitativnih karakteristika [1]. Ovo istraživanje ima sasvim drugačije polazne principe u merenju efektivnosti i nudi novi pristup za procenu čitavog procesa. Metoda koja se ovde predlaže ima kvantitativni pristup pri određivanju i merenju pravih faktora efektivnosti.

U nastavku će se pomenuto istraživanje predstaviti u najsažetijem obliku, tako što će se fokusirati na najznačajnije delove i na prikazivanje osnovne konцепције. Neka teoretska pitanja ostavljena su po strani uz pretpostavku da o ovoj materiji postoje već određena elementarna predznanja.

2 UDRUŽIVANJE ODNOŠNO POSLOVNO UMREŽAVANJE KAO FENOMEN

Stvaranje poslovne mreže je sastavni deo savremene poslovne strategije. Poslovne mreže stvaraju se između preduzeća koja u svom poslovanju zajednički proizvode neku dodatu vrednost. U savremenoj literaturi postoje mnoge definicije poslovnog umrežavanja [2],[3],[4]. Za Milera i Vilsona [5] umrežavanje označava razmenu i uzajamno delovanje između kompanija. U kontekstu finansijskih preduzeća fenomen umrežavanja predstavlja mešavinu konkurenčije u tržišnom smislu i saradnje u smislu hijerarhije.

Nivoi poslovnog umrežavanja mogu se ilustrovati podelom načina umrežavanja na tri osnovne vrste [6]:

1. Horizontalno umrežavanje predstavlja saradnju između preduzeća, koja se bave istom vrstom delatnosti i nalaze se na istom nivou u vrednosnom lancu.
2. Vertikalno umrežavanje predstavlja saradnju između preduzeća koja se bave istom vrstom delatnosti na sukcesivnim nivoima u vrednosnom lancu.

3. Collaboration where lines of business are exceeded. For example in R&D functions and other common interests.

Enterprises should focus on their core competences. In future it is more important to find ways how the enterprise can use networks to enrich its own core competence.

A "Make or buy"- decision associates with co-operational working and networking. Stable network, which acts even with everybody's purpose, is hard accomplish. Anyway right decisions and accurate long and short distance planning helps with producing benefit by every decision making point.

3 MAKE OR BUY DECISIONS AND CORE COMPETENCE

Company strategy is a foundation for production strategy, which gives basic lines for procurement strategy of a firm. [3]

Make or buy decisions are often done in item or product range level. Usually firms don't have, even if they should, calculations or other given data to support their decisions. Decisions are often based on somebody's views and feelings and therefore frequently mislead company into the wrong path. [4], [5]

Producing it by selves or buying it from outer markets is always a strategic decision. Company politics gives standards in which organisation can operate in make or buy decisions. Often these decisions are more than just financial-related e.g. company's core competencies have an influence on it. [5]

Strategic procurement needs to find ways to identify its strengths and weaknesses. Before this it cannot be able to find solutions for improving its ways to operate in the field of outsourcing. Core competence approach is only one way to identify this matter. Other ways are (Greaver 1999: 5):

1. Organisational reasons (e.g. improving efficiency, flexibility etc.)
2. Development of operations (e.g. improving performance, experticing, managing etc.)

3. Postoji i saradnja u slučaju kada se izlazi iz okvira poslovnog delovanja, na primer u oblasti istraživanja i razvoja i drugih delatnosti od zajedničkog interesa.

Pojedinačna preduzeća se, prvenstveno, orientišu na poslovanje u oblasti svoje osnovne delatnosti. Međutim, u budućnosti, daleko je značajnije pronaći načine na koje bi preduzeće moglo da koristi poslovne mreže radi unapređivanja i proširivanja svoje osnovne delatnosti.

Odluka tipa "napraviti ili kupiti" vrlo često je povezana sa raznim oblicima poslovne saradnje i umrežavanja. Stabilna poslovna mreža, koja podjednako ispunjava ciljeve svih učesnika je veoma teško ostvarljiva. U svakom slučaju, ispravne odluke i precizno kratkoročno i dugoročno planiranje pomažu u ostvarivanju dobiti u svakoj fazi odlučivanja.

3 ODLUKE TIPA "NAPRAVITI ILI KUPITI" I OSNOVNA DELATNOST

Strategija jednog preduzeća predstavlja osnov proizvodne strategije, koja daje osnovni okvir za strategiju nabavke jedne kompanije [3].

Odluke tipa "napraviti ili kupiti" obično se donose na nivou pojedinačnih stavki ili proizvoda. Preduzeća obično ne raspolažu, iako bi to bilo neophodno, preciznim kalkulacijama ili nekim drugim relevantnim podacima na kojima bi zasnivala svoje odluke. Odluke se obično donose na osnovu nečijih stavova ili osećaja, što često odvodi preduzeće na pogrešan pravac [4], [5].

Da li će svoje potrebe zadovoljiti iz sopstvenih resursa, ili na tržištu, uvek predstavlja strateško pitanje za jedno preduzeće. Poslovna politika kompanije pruža osnovne standarde u okviru kojih će ona poslovati i donositi odluke tipa "napraviti ili kupiti". Ovakve odluke često nisu samo finansijske prirode, na primer na pomenutu odluku može uticati osnovna specijalnost preduzeća [5].

Strategija nabavke jednog preduzeća mora pronaći načine da identifikuje sopstvene prednosti i slabosti. Bez toga ono neće biti u stanju da na najbolji mogući način koristi sopljašnje resurse. Princip osnovne specijalnosti je samo jedan od pristupa da se definise ovo pitanje. Ostali pristupi zasnivaju se na sledećim principima (Greaver 1999: 5):

1. organizacija (npr. povećanje produktivnosti, fleksibilnosti itd.),
2. razvoj (npr. poboljšana efektivnost, povećanje nivoa stručnosti, način upravljanja itd.),

- 3. Financial related (e.g. reducing investing and targeting it in new opportunities etc.)
- 4. Income related (opening the new markets via e.g. new suppliers)
- 5. Cost related (reducing costs via superior performance of suppliers sales network)
- 6. Labour related (making solid based careers for workers etc.)
- 3. finansijske (npr. smanjenje nekih investicija i usmeravanje sredstava ka drugim poduhvatima),
- 4. dohodak (otvaranje tržišta preko npr. novih dobavljača),
- 5. troškovi (smanjenje troškova unapređenjem efektivnosti dobavljačke prodajne mreže),
- 6. radna snaga (obezbeđenje solidne osnove za napredovanje u karijeri itd.).

Core competence approach was the most useful for the need of this investigation. Real challenge for enterprises is how to produce such a competence that is highly appreciated among customers in the long run. Quinn & Hilmer [7] state that problems may occur when managers focus too much on products and services or act too rigid with matters that don't meet the requirements of the customer.

Core competence is co-operation between large and small entities. Collaborational efficiency is determined as whole. Prahalad & Hamel [8] advice managers think core competence in according to equation 1.

$$\text{Core competence} = \text{technology} \times \text{control process} \times \text{collective learning}$$

(1)

For understanding the equation it is important to notice that, it is not a sum but a multiplication of factors.

4 MANAGING OUTSOURCING BY PERFORMANCE

Well-known and universal pattern for managing outsourcing is not available but every process should be performed by need of the organisation. Bendor-Samuel et al [9],[10] state that well established performance metrics are starting-point for developing right type of supplier relationships.

Outsourcing relationship falls into conflict frequently during its life cycle. Bendor-Samuel shows the problem of managing the outsourcing by container model. Figure 1 illustrates the basic problem in outsourcing, which results from different needs of customer and suppliers. It is a question of pressure in container. When opposite and noxious components occur in relationships the pressure in container increases. It is notable that pressures increases with effect of each of the participants, the customer and the supplier.

Princip osnovne specijalnosti preduzeća je za potrebe ovog istraživanja bio najsvršishodniji. Pravi izazov za svako preduzeće predstavlja pitanje kako obezbediti onaj nivo kompetentnosti u okviru svoje osnovne specijalnosti, zbog koga će među korisnicima biti cenjen u dužem vremenskom periodu. Quinn & Hilmer [7] tvrde da do problema može doći kada se rukovodioci previše fokusiraju na proizvode i usluge, ili imaju suviše krut pristup u odnosu na zadovoljavanje potreba korisnika.

Osnovna specijalnost istovremeno podrazumeva i saradnju između velikih i malih celina. Efektivnost koja se ostvaruje kroz saradnju ocenjuje se kao celina. Prahalad & Hamel [8] preporučuju rukovodicima da nivo kompetentnosti u okviru osnovne specijalnosti određe primenom sledeće jednačine 1:

$$\text{nivo kompetentnosti u okviru osnovne specijalnosti} = \text{tehnologija} \times \text{kontrolni procesi} \times \text{kolektivno znanje}.$$

(1)

Da bi se bolje shvatila pomenuta jednačina važno je napomenuti da se ne radi o prostom zbiru, već o multiplikaciji faktora.

4 UPRAVLJANJE SPOLJNIM RESURSIMA PREKO EFEKTIVNOSTI

Ne postoji univerzalan, opšte prihvaćen obrazac za upravljanje spoljnim resursima, međutim, svaki proces treba da bude usklađen sa potrebama određene organizacije. Bendor-Samuel et al [9],[10] tvrde da je pravilno postavljen obrazac efektivnosti polazna osnova za razvoj dobrih odnosa sa dobavljačima.

Međutim, prilikom korišćenja spoljašnjih resursa međusobni odnosi često zapadaju u konfliktnе situacije. Bendor-Samuel et al koriste model zatvorenog suda radi bolje ilustracije problema upravljanja spoljnim resursima. Slika 1 prikazuje osnovni problem korišćenja spoljnih resursa, koji proizilazi iz različitih poreba korisnika i dobavljača. To je naime, pitanje pritiska koji nastaje unutar zatvorenog suda. Kada štetne i suprotstavljene tendencije deluju unutar nekog odnosa, odnosno entiteta, pritisak počinje da raste kao u zavorenom sudu. Značajno je primetiti da prisak raste usled delovanja svakog pojedinačnog učesnika, kako korisnika tako i dobavljača.

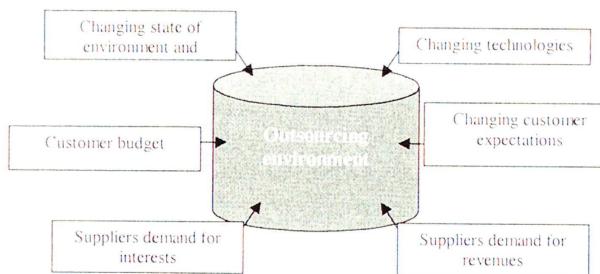


Figure 1 Managing Outsourcing Relationship – Container model [9]

slika 1 Upravljanje odnosima u procesu korišćenja spoljnih resursa - model zatvorenih sudova [9]

Measuring performance is an effective tool for reducing pressure in container. By the aid of measuring, supplier aim for business objects and produce added value for its own business [9].

Merenje efektivnosti procesa je metoda korisna za smanjenje pritiska unutar zatvorenog suda. Uz pomoć merenja, dobavljač određuje svoje poslovne ciljeve i proizvodi dodatu vrednost svom preduzeću [9].

5 PERFORMANCE MEASUREMENT

Kelvin W.T 1907-1982 once cited: "When you can measure what you are speaking about and express it in number you know something about it... otherwise your knowledge is a meager of unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in thought advanced to stage of science."

As Kelvin W.T indicated one must start quantifying thing when trying to get deeper knowledge of it. It's important to achieve understanding of the performance before it can be measured.

Performance measurement has been researched widely in branch of business networks. Final outcome of the studies has mainly been very uncomplicated – different companies have different needs and standards that show the areas in which the measurement should be performed.

Despite of the company's business area the performance measurement is valid with four things [9]:

1. You can't manage what you can't measure.
2. Performance measurement standards should be measurable and achievable.
3. You must only measure meaningful things.
4. Performance metrics should be balanced. Using too many measures can run into mislead information. On the other hand too few measures can stand for difficult manageable networks. Also timing of the measurement should be balanced.

All these sections presents that is has to be seriously understood what has to be measured,

5 MERENJE EFEKTIVNOSTI PROCESA

Kelvin W. T. (1907-1982) jednom je rekao: "Kada možeš da izmeriš ono što govorиш i da to brojčano izraziš, onda o tome nešto znaš, u suprotnom, tvoje znanje je veoma tanko i prilično nedovoljno, može predstavljati početak znanja, ali si ti, jedva i samo, u mislima dostigao nivo nauke."

Kao što je Kelvin W. T. napomenuo početni korak u sticanju pravih znanja je kvantifikovanje nekog pojma. Pre nego što se neki pojам ili proces izmeri, potrebno je prvo shvatiti način na koji on funkcioniše.

Merenje efektivnosti detaljno se istražuje u pojedinim segmentima poslovne mreže. Rezultat ovih istraživanja je u većini slučajeva bio veoma jednostavan - različite kompanije imaju različite potrebe i standarde koji ukazuju na oblasti u kojima merenja treba da budu izvršena.

Uprkos ograničenosti ovih merenje četiri elementa su opšte važeća [9]:

1. Može se upravljati samo onim procesima koji se mogu izmeriti.
2. Standardi za merenje efektivnosti moraju biti merljivi i ostvarljivi.
3. Mogu se meriti samo sadržajni pojmovi i procesi.
4. Merenje mora biti izbalansirano. Preveliki broj mernih jedinica mogu da dovedu u zabludu i navedu na pogrešne zaključke, dok s druge strane, isuvise mali broj jedinica neće biti dovoljan za analizu komplikovanih sistema. Osim toga, period u kome će se vršiti merenje mora, takođe, biti pažljivo odabran.

Iz ovoga se može zaključiti da je veoma važno definisati šta je predmet merenja, koje se jedinice

what measures should be used, when/where measurement should be taken its place and how often measurement should be repeated.

Defining the areas of measurement is one critical part of whole journey of performance measurement. According the Spekman [53] well-made performance measures should give both quantitative and qualitative results. More specified information of performance measurement levels give Sand cone – model [12]. According to this model development should be started from bottom in order to achieve better performance. Proceeding step by step from quality to reliability and thereafter to speed and cost-efficiency gives best total performance. However Bendor-Samuel [4],[5],[6] state that development should have a positive effect on cost efficiency; otherwise there is no development at all.

koriste, kada/gde treba obaviti merenje i koliko često.

Definisanje premeta i oblasti koju treba proceniti je ključnii deo celog procesa merenja efektivnosti. Prema Spekmanu [53] dobro obavljeni merenje efektivnosti treba da pruži, kako kvantitativne, tako i kvalitativne rezultate. Pomoću modela peščanog sata [12] mogu se obezbediti specifičniji podaci o merenju efektivnosti. Prema ovom modelu, da bi se postigla bolja efektivnost proces treba da se razvija postepeno od same osnove. Postupajući korak po korak od kvaliteta preko pouzdanosti, pa do brzine i ekonomičnosti, dobijaju se najbolji ukupni rezultati. Međutim, Bendor-Samuel at al [4],[5],[6] tvrde da ovaj razvojni proces mora imati pozitivne ekonomske efekte, jer, u suprotnom ne može se govoriti o razvoju.

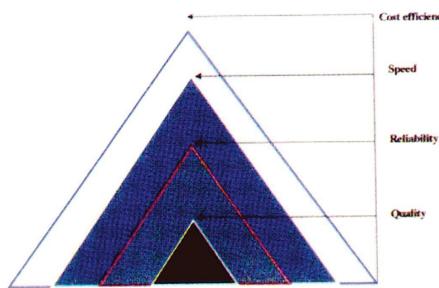


Figure 2 Sand cone model [12]
slika 2 Model peščanog sata [12]

Defining performance measures should be devided in three different phases [14]:

1. Performance measure should be a combination of more than three measures.
2. Measures have to be chosen according the business objectives.
3. Decide, which are the most important attributes for measurement.
4. Define, the importance of measures, according to what purpose they are used.

Bendor-Samuel [5] shows the metric framework for balanced measurement (fig. 3). Vertical axis shows the connection of metrics to the business objectives. Lower measures in matrix are called diagnostic measures. Diagnostic measures stands for measuring actual outcome of results (processes, services, products etc). Business oriented measures measure correspondingly the supplier influence on customer business objectives.

Definisanje mernih jedinica treba da bude podeljeno na tri različite faze [14]:

1. Merenje efektivnosti treba da predstavlja kombinaciju najmanje tri mernih jedinica.
2. Merne jedinice moraju biti izabrane u skladu sa poslovnim ciljevima.
3. Treba definisati koje su najvažnije karakteristike merenja.
4. Treba definisati značaj mernih jedinica u skladu sa njihovom namenom.

Bendor-Samuel at al [5] prikazuju merni okvir jednog dobro izbalansiranog merenja (slika 3). Vertikalna osa pokazuje povezanost između odabranih jedinica i poslovnih ciljeva. Jedinec koje su prikazane u donjem nizu matrice nazivaju se dijagnostičke jedinice. Dijagnostičke jedinice predstavljaju konačne rezultate (procesi, usluge, proizvodi utd.). Jedinice orijentisane na poslovne ciljeve služe da procene uticaj dobavljača na poslovne ciljeve korisnika.

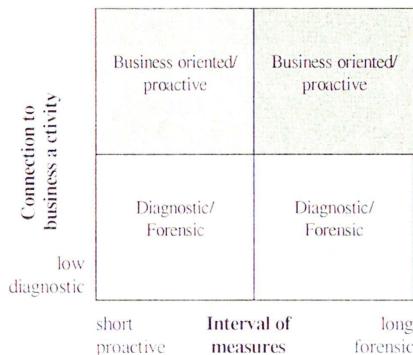


Figure 3 Metric Framework [5]

slika 3 Merni okvir [5]

Nor single measure can give straight answer to performance measurement; more or less has always been the question of balancing different measures

6 DMSPM – THE DYNAMIC MODEL FOR SUPPLIER PERFORMANCE MEASUREMENT

Dynamic Model for Supplier Performance Measurement (DMSPM) stands for whole process, which is needed for performance measurement (fig.4). It starts from qualitative tools (step 1 in fig. 4), which helps getting the information from research area. This part of the process can be adapted with many suitable tools according to business field, processes etc. Qualitative part of DMSPM is a part where current state of the business is analyzed.

The DMSPM make a use of basic tools from QMPMS-process [7], AHP [45],[48],[49], and TAST-method [18],[19],[55]. These methods form the quantitative base of the DMSPM.

Steps 2 and 3 form the shape of the hierarchy. Qualitative performance attributes, which are found in step 1 gets so a quantitative form of existence. This part of the whole DMSPM process is the most critical. Failure in this part leads often in unrealistic outcomes. Cognitive maps are used to help to visualize and comprehend the relation between the performance attributes [6],[31].

Step 4 uses AHP (analytical hierarchy process) to systematically evaluate the priorities of different performance attributes. Furthermore all the factors get a weighted value, which gives them a different importance in performance measurement. Rangone [45] introduced the use of AHP in searching the performance attributes. Even if there are many different modern tools for performance measurement none of them have strived to quantify the performance attributes. AHP is a

Ne postoji ni jedna jedinica pomoću koje bi se mogla neposredno izmeriti efektivnosti, već je to u većini slučajeva niz dobro izbalansiranih jedinica.

6 DINAMIČKI MODEL ZA MERENJE EFEKTIVNOSTI DOBAVLJAČA - DMMED/DMSPM

Dinamički model za merenje efektivnosti dobavljača (DMSPM) predstavlja čitav postupak kroz koji se mora proći radi ocene efektivnosti (slika 4). Prvi korak predstavljaju kvalitativne metode (nivo-1 na slika 4) koji omogućava prikupljanje podataka putem istraživanja određene oblasti. U ovoj fazi procesa mogu se uvesti odgovarajuće pomoćne metode namenjene posebnim oblastima poslovanja, procesima itd. U ovoj kvalitativnoj fazi DMSPM istražuje se trenutno stanje u kome se neka poslovna aktivnost nalazi.

DMSPM koristi različite osnovne metode od QMPMS-procesa [7], AHP [45],[48],[49], i TAST-metode [18],[19],[55] koje čine kvantitativnu bazu DMSPM

Faze 2 i 3 imaju hijerarhijsku strukturu. Kvalitativne karakteristike efektivnosti, koje su određene u toku prve faze dobijaju kvantitativnu formu. Ovo je ključna faza celog DMSPM procesa. Greške u ovoj fazi dovode do nerealnih rezultata. Za vizuelizaciju i rezumevanje odnosa između pojedinačnih karakteristika efektivnosti koriste se kognitivne mape [6],[31].

U fazi 4 koristi se AHP (postupak analitičke hijerarhije) kako bi se sistematizovale različite karakteristike efektivnosti po prioritetima. Osim toga, svim faktorima dodeljuje se ponderisana vrednost, kojom se određuje njihov značaj u merenju efektivnosti. Rangone [45] uveo je upotrebu AHP u želji da definiše karakteristike efektivnosti. Iako ima puno savremenih metoda i postupaka koji se koriste za ocenu i merenje

convenient tool for doing this. AHP consist of four different phases:

1. Outlining the problem of decision-making into hierarchy.
2. Performing the pair wise comparisons.
3. Estimating the local priorities.
4. Estimating the relative weighted values of each factor according to global priorities.

Tast-analysis forms the last step of DMSPM. TAST is an abbreviation of Finnish words Toimittaja-Arvioinnin Systemaattinen Toteuttamismenetelmä that is a systematic method for the supplier evaluation in English [19]. In TAST method the grade is computed to every combinations of supplier and product (or service) group. The purpose of the grade is to measure the performance of the supplier in a certain product (or service) group. The most interesting development area in TAST have been the determination of weighted values. DMSPM process gives hopefully a cure for this matter.

efektivnosti, ni jedan od njih nije uspeo da kvalificuje karakteristike efektivnosti osim AHP-a. Ovaj postupak sastoji se iz četiri etape, tj. potrebno je:

1. definisati mesto odlučivanja u hijerarhijskoj strukturi,
2. poređenje po parovima,
3. procena lokalnih prioriteta i
4. procena relativnih ponderisanih vrednosti svakog faktora prema globalnim prioritetima.

Test analiza predstavlja poslednju fazu DMSPM. Metoda TAST (skraćenica fraze na finskom Toimittaja-Arvioinnin Systemaattinen Toteuttamismenetelmä) je metoda za sistematsku ocenu dobavljača [19]. Određena kvalifikacija, odnosno ocena izračunava se za svaku kombinaciju dobavljač-grupa proizvoda (ili usluga). Svrha ove ocene je izmeriti efektivnost dobavljača u kontekstu neke određene grupe proizvoda ili usluga. Najinteresantniji segment ove metode je određivanje ponderisanih vrednosti. Postupak DMSPM će dati odgovore na neka od ovih pitanja.

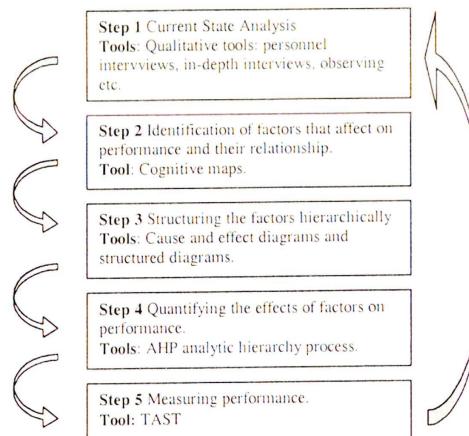


Figure 4 DMSPM – Principles
slika 4 DMSPM – Principi

7 FRAMEWORK OF THE STUDY

Framework of the study is imitated from steps of DMSPM.

A. Current state analysis

Process description tool enabled a bound for DMSPM and for localizing the attributes, which have an affect on performance of the company.

- Main attributes were found on the early point of QMPMS process.
- Deeper knowledge of company activities was found:

7 OKVIR ISTRAŽIVANJA

Okvir ovog istraživanja predstavljaju faze DMSPM.

A. Analiza trenutnog stanja

Opisivanje procesa omogućava određivanje DMSPM i lokalizaciju karakteristika, koje imaju uticaj na efektivnost poslovanja kompanije.

- Osnovne karakteristike lokalizovane su u ranoj fazi QMPMS procesa.
- Došlo se do dubljih saznanja o poslovanju kompanije:

- Research area seemed to have decisive affect on whole plant production.
- Already some of the main performance attributes of the whole supplier chain were found.

B. QMPMS

Current state analysis helped in formation of QMPMS. There was an objective to find and sketch out all attributes and characteristics affecting on performance on research area. Base for whole process was to find general objective for research area development. Interview based problem solving gave variations for what could be the objective. Interviews were performed among the personnel of research area. Table 1 illustrates some examples of different objectives:

Table 1 Objectives for performance measurement

Interview	Object
Mr 1	"Efficiency in production process and maintenance services"
Mr 2	"Undisturbed process, quality of work site and cost efficiency"
Mr 3	"Ensure process undisturbeness in every circumstances"
Mr 4	"Functionality of production process"

The functionality of the production process was natural all-inclusive selection to be the main objective of all sub objectives.

Study proves that critical services and spare parts have the base for whole supplier performance in the research area. Therefore prioritizing the services and spare parts upon the general objective had to be done. Next step in DMSPM was to find and measure causality of different attributes found during the process description and cognitive mapping. Determining the causalities helped considerably the formation of hierarchy of AHP (fig. 5).

- Istraživanja oblast izgleda ima odlučujući uticaj na ukupnu proizvodnu delatnost kompanije.
- Već su pronađene neke glavne karakteristike efektivnosti čitavog lanca dobavljača.

B. QMPMS

Analiza trenutnog stanja omogućila je formiranje QMPMS. Cilj je bio da se pronađu i definišu svi atributi i karakteristike koje utiču na efektivnost u svakoj istraživanoj oblasti. Osnova čitavog procesa bila je u pronalaženju zajedničkog cilja razvoja istraživane oblasti. Za rešavanje problema mogu se organizovati ankete koje će pružiti čitav niz odgovora na pitanje, koji može biti zajednički cilj. Svi zaposleni u sektoru koji se istražuje se anketiraju. U tabeli 1 prikazani su neki primeri različitih ciljeva.

tabela 1 Ciljevi merenja efektivnosti

Anketa	Cilj
G-din 1	"Efikasnost proizvodnog procesa i održavanje "
G-din 2	"Neometano odvijanje procesa, dobri uslovi za rad i ekonomičnost"
G-din 3	"Obezbeđenje neometanog odvijanja procesa u svim okolnostima"
G-din 4	"Funkcionalnost proizvodnog procesa"

Funkcionalnost proizvodnih procesa je globalni zajednički cilj i za sve sekundarne ciljeve. Istraživanje pokazuje da ključne usluge i rezervni delovi predstavljaju osnovu za celokupnu efektivnost dobavljača u istraživanoj oblasti. Prema tome, treba izvršiti klasifikaciju usluga i rezervnih delova prema prioritetima, a u skladu sa zajedničkim ciljem. Sledeći korak u realizaciji DMSPM je pronalaženje i merenje faktora koji prouzrokuju određene karakteristike konstatovane opisom procesa i pravljenje kognitivnih mapa. Definisanje uzročnika bilo je od velike pomoći prilikom formiranja hijerarhijske strukture AHP-a (slika 4).

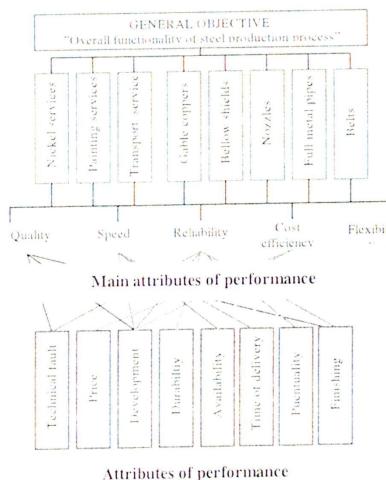


Figure 5 AHP – The hierarchy
slika 5 AHP – Hijerarhijska struktura

Decision making hierarchy of AHP was formed to answer the problematic question "what should be measured". This question can be kept as a key for whole measurement process [29]. First level of hierarchy is reserved for general objective. This level spreads the whole hierarchy in lower levels. The lowest level is formed of found performance attributes in research area. At this stage the question "what should be measured" is answered. The global priorities of these attributes are the most important for successful measurement.

Next step of AHP is comparative judgment [49]. Attributes should be evaluated with their relative importance to the general objective.

First step of comparative judgment is to calculate eigenvectors of each row in a decision matrix (eq. 3).

$$\sqrt[4]{\frac{w_1 \times w_1}{w_1} \times \frac{w_1 \times w_1}{w_2} \times \frac{w_1 \times w_1}{w_3} \times \frac{w_1 \times w_1}{w_4}} \quad (3)$$

At second step every eigenvector component is summarized. Local priorities (priorities at every row) are finally calculated. Consistency of local priorities has to be studied before the overall (global) priority can be determined.

AHP gives a tool for calculating the consistency of AHP-hierarchy. Equation 4 shows the idea of calculating consistency index (C.I.). In simplification it can be said that greater the value of C.I. is the inconsistent the hierarchy and its pair wise comparisons are.

$$C.I. = \frac{\lambda_{\max-n}}{n-1} \quad (4)$$

Tables 2-4 show the example of result in pair wise comparison from hierarchy level 1 to 3.

Table 2 Pairwise comparison at level 1
tabela 2 Poređenje po parovima na nivou 1

	Service 1	Service 2	Service 3	Product 1	Product 2	Product 3	Product 4	Product 5		C.I. ($\lambda_{\max-n}$)/(n-1)	C.R.
Service 1	1	9	4	1	7	6	3	1	=	-0.293	0.239
Service 2	0.111	1	0.333	0.111	0.333	0.2	0.333	0.125	=	-0.0238	0.0194
Service 3	0.25	3	1	0.111	0.333	0.2	0.25	0.2	=	-0.0385	0.0314
Product 1	1	9	9	1	9	7	9	2	=	-0.4121	0.336
Product 2	0.143	3	3	0.111	1	0.5	1	0.25	=	-0.0588	0.0479
Product 3	0.167	5	5	0.143	2	1	3	0.25	=	-0.103	0.084
Product 4	0.333	3	3	0.111	1	0.333	1	0.25	=	-0.0632	0.0516
Product 5	1	8	5	0.5	4	4	4	1	=	-0.2338	0.1907
Σ	4.004	41	30.33	3.087	24.67	19.23	21.58	5.075	Σ	-1.2263	8.6215

Hijerarhijska struktura u procesu odlučivanja u AHP formirana je tako da pruži odgovor na ključno pitanje. Ovo pitanje može biti putokaz u toku čitavog procesa merenja [29]. Prvi nivo hijerarhijske strukture rezervisan je za zajednički cilj i predstavlja osnovu cele strukture. Donji nivo se formira na osnovu definisanih karakteristika efektivnosti koje se odnose na istraživano područje. Na ovom nivou se odgovara na pitanje "šta treba izmeriti?". Za uspešno merenje potrebno je odrediti opšte prioritete pomenutih atributa.

Sledeći korak u realizaciji AHP je komparativno ocenjivanje [49]. Karakteristike treba proceniti u skladu sa značajem koji imaju u odnosu na zajednički cilj.

Prva etapa komparativnog ocenjivanja sastoji se iz izračunavanja eigenvektora za svaki red u matrici odlučivanja (formula 3).

$$\sqrt[4]{\frac{w_1 \times w_1}{w_1} \times \frac{w_1 \times w_1}{w_2} \times \frac{w_1 \times w_1}{w_3} \times \frac{w_1 \times w_1}{w_4}} \quad (3)$$

U drugoj etapi svaka komponenta eigenvektora se sabira. Lokalni prioriteti (prioriteti u svakom redu) se konačno obračunavaju. Konzistentnost lokalnih prioriteta se mora proučiti pre nego što se odrede sveobuhvatni (opšti) prioriteti.

AHP obezbeđuje metod za izračunavanje konzistentnosti hijerarhijske strukture AHP-a. Jednačina 4 pokazuje koncepciju izračunavanja indeksa konzistencije (C.I.). Jednostavnije, može se reći da što je veća vrednost C.I., to će i nekonzistentnost hijerarhijske strukture biti veća, a poređenje po parovima bi glasilo:

$$C.I. = \frac{\lambda_{\max-n}}{n-1} \quad (4)$$

Tabele 2-4 prikazuju primer rezultata poređenja po parovima od 1 do 3 hijerarhijskog nivoa.

Table 3 Pair wise comparison at level 2
tabela 3 Poređenje po parovima na nivou 2

Effect on service x					
	Quality	Speed	Reliability	Cost efficiency	Flexibility
Quality	1	6	5	5	4
Speed	0.167	1	0.333	1	1
Reliability	0.333	3	1	3	2
Cost efficiency	0.333	1	0.333	1	0.5
Flexibility	0.333	1	0.05	2	1
Σ	2.167	12	7.167	12	8.5

Value of eigenvector					
	C.I. ($\lambda_{\max} \cdot n$) / (n-1)	λ_{\max}	C.R.	C.R.	C.R.
$\Sigma_{\max} = \lambda_{\max}$					
2.2187773491	0.522811	1.13275705	0.123143	0.109949	
0.333594238	0.078605	0.94326015			
0.843993573	0.198871	1.42524015			
0.356189389	0.083929	1.00714946			
0.49138015	0.115784	0.98416573			
Σ	4.243930842	5.49257253			

Table 4 Pair wise comparison at level 3
tabela 4 Poređenje po parovima na nivou 3.

Effect on quality			
	Quality	Speed	Reliability
Technical error	1	5	9
Development	0.2	1	3
Finishing	0.1111	0.3333	1
Σ	1.3111	6.3333	13

Value of eigenvector					
	C.I. ($\lambda_{\max} \cdot n$) / (n-1)	λ_{\max}	C.R.	C.R.	C.R.
$\Sigma_{\max} = \lambda_{\max}$					
-3.844	0.7514	0.9852	0.0145	0.0251	
-0.912	0.1782	1.1285			
-0.36	0.0704	0.9154			
-5.116	3.029				

C. TAST – analysis

The outcome of QMPMS was the global priorities of the performance attributes. TAST analysis is now the last phase in DMSPM.

Importance of measure (that is weighted value) had to be defined before any calculations of actual performance could be done. Dividing the attributes found in AHP into attributes and main attributes of performance did this possible. Once attributes were easy to find from global priority calculations of the AHP hierarchy the weighted values of main attributes were easy to calculate.

Fig. 5 shows the weighted values of main performance attributes and performance attributes determined according to QMPMS. It is important to notice that performance attributes are totally eight and they divide differently between all the main performance attributes. For example development occur in every dimension of main attributes, but availability is present in only two.

C. TAST – analiza

Na osnovu QMPMS određuju se karakteristike efektivnosti po opštim prioritetima. TAST analiza predstavlja poslednju fazu DMSPM.

Pre nego što se pređe na bilo kakvo izračunavanje efikasnosti mora se precizno definisati mera, odnosno ponderisana vrednost. Ovo je omogućila podela karakteristika određenih u toku AHP na obične i glavne karakteristike efektivnosti. Kada se na osnovu obračuna opštih prioriteta hijerarhijske strukture AHP omogući definisanje običnih karakteristika, veoma je jednostavno izračunati ponderisane vrednosti glavnih karakteristika.

Slika 5 prikazuje ponderisane vrednosti osnovnih karakteristika efektivnosti i karakteristika efektivnosti određenih na osnovu QMPMS. Važno je zapaziti da ima ukupno osam karakteristika efektivnosti i da su različito raspoređene među glavnim karakteristikama efektivnosti. Na primer, do razvoja dolazi u svakom aspektu glavnih karakteristika, ali je zato raspoloživost prisutna samo u dva.

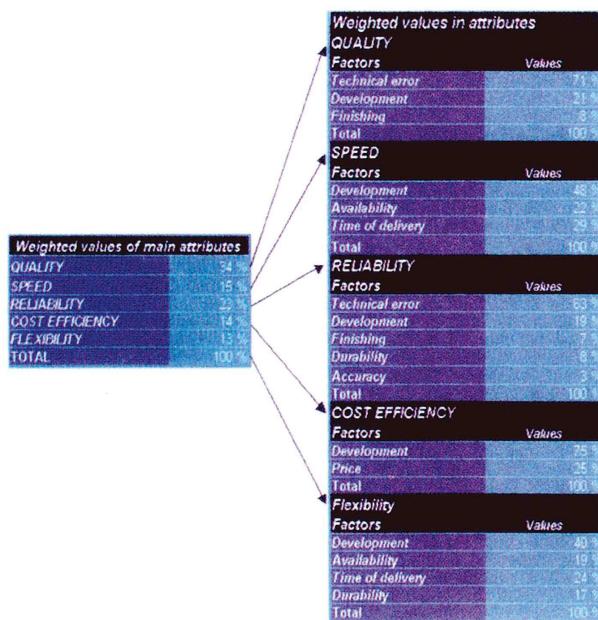


Figure 5 Weighted values from QMPMS.
slika 5 Ponderisane vrednosti iz QMPMS.

Producing data for only the purpose of performance measurement system is time consuming and very expensive. Usually firms produce already the information for supplier performance measurement, but don't know how to gather the information and use it. It is important to use all the existing information so that the measurement system will not become too laborious to keep on. In this investigation performance attributes was totally found eight. Every attribute was decided to measure with one extensive measure. For example measuring attribute price was done by establishing measure which compared the last years most favourable price to average of price in given period. Information was obtained from company's internal operational computer system.

When every attribute had its own measure the execution of TAST-analysis became possible. Supplier based performance result is divided (in this investigation) in five different areas. That is quality, speed, reliability, cost-efficiency and flexibility. These attributes are to be measured with chosen performance attributes. To clarify this aspect following equations will illustrate the calculation of main attribute (eq. 5) and supplier based performance (eq. 6).

Generisanje podataka isključivo zbog merenja efektivnosti nekog sistema zahteva dosta vremena i veoma je skupo. Kompanije obično raspolažu podacima za merenje efektivnosti dobavljača, ali ne znaju kako da ih sakupe i upotrebe. Važno je iskoristiti sve postojeće informacije, tako da proces merenja ne postane previše naporan i zahtevan. U ovom istraživanju ukupno je pronađeno osam karakteristika, odnosno atributa efektivnosti. Predviđeno je da se svaka karakteristika izmeri pomoću jedne sveobuhvatne merne jedinice. Na primer, merenje cene kao karakteristike obavljeno je tako što je usvojena merna jedinica koja je služila za poređenje vrednost najpovoljnije prošlogodišnje cene sa prosečnom cenom u datom periodu. Podaci su dobijeni iz internog operativnog sistema kompanije.

Sprovođenje TAST analize moguće je kada svaka karakteristika ima svoju mernu jedinicu. Rezultati efektivnost dobavljača deli se (u ovom istraživanju) na pet različitih oblasti. To su kvalitet, brzina, pouzdanost, ekonomičnost i fleksibilnost. Ove karakteristike mere se pomoću odabranih atributa efektivnosti. Da bi se razjasnilo ovo gledište sledeće jednačine će ilustrovati način izračunavanja glavne karakteristike, odnosno osnovnog atributa (jedn. 5) i efektivnost dobavljača (jedn. 6).

$$\text{Quality} = \sqrt{\text{technical fault}^{0.7079} \times \text{Development}^{0.2081} \times \text{Finishing}^{0.0840}} \quad (5)$$

$$\text{Total result of supplier} = \sqrt{\text{Quality}^{0.6303} \times \text{Speed}^{0.15} \times \text{Reliability}^{0.23} \times \text{CostEfficiency}^{0.14} \times \text{Flexibility}^{0.13}} \quad (6)$$

8 CONCLUSION OF INVESTIGATION

Many development potential were found during the investigation. Outlining and prioritising the performance attributes were easily accomplished. Defining attribute-based priorities with help of AHP was the key for DMSPM. With the help AHP is possible to balance the diagnostic [3],[4],[5] area of measurement system according to target and object of measurement.

TAST analysis is appropriated tool for seeking the deviations of performance. However the method itself need further examination so that the cause-effect relations of performance could more easily be directed.

During the investigation an operative system for DMSPM was developed. In future development for integrated DMSPM will be done. Idea is to expand the measurement into all business units. Under the circumstances supplier based results wouldn't be just business unit based but company based results.

8 ZAKLJUČAK ISTRAŽIVANJA

U toku ovog istraživanja pronađeni su mnogi razvojni potencijali. Definisanje i određivanje atributa efikasnosti po prioritetima je bilo jednostavno postići. Određivanje prioriteta na osnovu karakteristika uz pomoć AHP je ključna faza DMSPM. Uz pomoć AHP moguće je izbalansirati dijagnostiku [3],[4],[5] mernog sistema u skladu sa ciljevima i prema predmetu merenja.

TAST analiza predstavlja pogodnu metodu za pronalaženje odstupanja u funkcionisanju nekog sistema. Međutim, sama metoda mora se dalje ispitati kako bi se moglo lakše upravljati uzročno-posledičnim odnosima unutar ovog procesa.

U toku istraživanja ustanovljen je i razvijen operativni sistem za DMSPM. U budućnosti se predviđa integriranje DMSPM. Osnovna ideja je da se merenja prošire na sve poslovne jedinice. U tim uslovima rezultati dobijeni na osnovu podataka o dobavljaču neće se odnositi samo na pojedine poslovne jedinice, već na čitavu kompaniju.

REFERENCES / LITERATURA

- [1] Alexander, M. & Young, D.: *Strategic Outsourcing*. Long Range Planning, 1996.
- [2] Bartram, P.: *Core Competencies - Building the Lean Enterprise, How Successful Organisations Leverage Core Competencies Through Strategic Alliances and Outsourcing*. Harper Broadbend Publications, Bury, Lancs, 1997.
- [3] Bendor-Samuel, P. & Goolsby, K.: *Risk Reward Pricing*. White Paper. Outsourcing Center, 2001.
- [4] Bendor-Samuel, P.: *Redefining Outsourcing - The Value Model*. Everest Group Inc., 1999.
- [5] Bendor-Samuel, P.: *Turning Lead Into Gold – The Demystification of Outsourcing*. Library of Congress Cataloging-in-Publication Data. USA, 2001.
- [6] Bititci, U.S, Suwigno, P & Carrie, A.S.: *Quantitative Models for Performance Measurement System*. International Journal of Production Economics 64(2000) P. 231-241, 2000.
- [7] Bititci, U.S, Suwigno, P. ja Carrie, A.S.: *Strategy management through quantitative modelling of performance Measurement Systems*. International Journal of Production Economics 64(2000) P. 231-241, 2001.
- [8] Boyson, S. & Corsi, T. M. & Dresner, M. E & Harrington.L.H & Rabinovith.E.: *Logistics and the Extended Enterprise, Benchmarks and Best Practices for the Manufacturing Professional*. John Wiley & Sons Inc, USA, 1999.
- [9] Chanda, S. & Mahanty, N.: Tata Tech Publication. *Outsourcing: The New Growth Paradigm*. Tata Tech 34/00. Vol. 29, No 1., 2000.
- [10] Child, J. & Faulkner, D.: *Strategies of Cooperations: Managing Alliances, Networks and Joint Ventures*. Oxford University Press, New York, USA, 1998.
- [11] Deming, W. Edwards: *Out of the Crisis*. MIT Press, Massachusetts Institute of Technology, Cambridge, USA, 1986.
- [12] Ferdows, K & De Meyer: *Lasting improvements in manufacturing performance in search of a new theory*. Journal of Operations Management v9, No 2, pp.168-194, 1990.
- [13] Gilroy, B. M.: *Networking in Multinational Enterprises*. The Importance of Strategic Alliances. South Carolina Press, Columbia, South Carolina, 1993.
- [14] Goolsby, K.: *A Guide for Establishing Service Level Specifications for Outsourcing Relationship*. White Paper. Outsourcing Center, 2001.

- [15] Greaver, H M.F.: *Strategic Outsourcing – A Structured Approach to Outsourcing Decisions and Initiatives*. 1999.
- [16] Grönroos, C.: *Nyt kilpailaan palveluilla*. Espoo, Finland: WSOY/Weilin+Göös, 2000.
- [17] Harrison, B.: *Lean and Mean. The Changing Landscape of Corporate Power in the Age of Flexibility*. Basic Book, New York, USA, 1994.
- [18] Hilmola, O. P. ja Takala, J.: *Performance Structure Model for Supplier Selection*. University of Vaasa. Proceedings of International Conference on Industrial Logistics, St. Petersburg, Russia, 1999.
- [19] Hilmola, O-P: *Benchmarkingin käyttö toimittajavalinnan kehittämisessä*. Vaasan Yliopisto, 1998.
- [20] Hirsjärvi, S. ja Hurme, H.: *Teeemahaastattelu*. Yliopistopaino, Helsinki, 1991.
- [21] Hovi, N.: *Outcomes of Interfirm Co-operation - a Case Study of Four Subcontractors*. Turku School of Economics and Business Administration.
- [22] Håkansson, H. & Snehota, I.: *Developing Relationships In Business Networks*. T.J. Press, Conwall, Great Britain, 1995.
- [23] Imppola, J.: *Hankintatoimen opetusmoniste*. Vaasan Yliopisto, 2000.
- [24] Jahnukainen, J., Lahti, M. & Virtanen, T.: *Toimittajayhteistyö tilausohjauvassa toimitusketjussa*. MET-julkaisu nro 3/1997, Helsinki, 1997.
- [25] Kajava, J & Jurvelin, P.: *Outsourcing as a Business Option in a Secure Distributed IT Environment*. (working paper) University of Oulu, Department of Information Processing Science, September 1996.
- [26] Karjalainen, J. Maijala, M. & Lindgren, M.: *Tuotannollinen ulkoistaminen*. MET-julkaisu nro 11/1999, Vantaa, 1999.
- [27] Koskinen, A, Lankinen, M., Sakki, J., Kivistö, T. & Vepsäläinen, A.P.J.: *Ostotoiminta yrityksen kehittämisessä*. WSOY. Porvoo, 1995.
- [28] Kuivanen, R. & Hyötyläinen, R.: *Kohti uudenlaisia yritysverkostoja: Monenkeskisen verkostoyhteistyön kehittäminen*. VTT Julkaisu. Offsetpaino, Espoo, 1997.
- [29] Laamanen, Kai, Laine, Risto, O., Pääkkönen Juha, Vakkuri Jorma, Vallinoja Veli & Väyrynen Pekka: *Mittaamisen parantaminen*. Laatukeskus. Helsinki: Oy Edita Ab, 1999.
- [30] Lamming, R. & Cox, A.: *Strategic Procurement Management in 1990s: Concepts and Cases*, Earlsgate Press, London 1995.
- [31] Laukkanen, M.: *Talous ja kieli seminaari 24.-25.4.1992 –HKKK*, 1992.
- [32] Lehtinen, U.: *A Study on the Evolution of Supply Chains and Subcontractors*, 2001.
- [33] Lehtonen, M.: *Preferenssien epävarmuusanalyysi AHP-päätösmalleissa*. Helsingin teknillinen korkeakoulu. Helsinki 1999.
- [34] Lilljander, V. & Strandvik, T.: *Estimating Zones of Tolerance in Perceived Service Quality and Perceived Service Value*. Working Paper 247, Swedish School of Economics and Business Administration. Karlstad Sweden, 1992.
- [35] Lindell, I. O. Mikkilä, & Penninkilampi, J.: *Rautaruukki –info*. Rautaruukki Steel Intranet, 2002.
- [36] Lynch, C. F.: *Logistics Outsourcing - a Management Guide*. Council of Logistics Management. USA, 2000.
- [37] Metalliteknikka. Tuotannon ulkoistaminen. Metalliteknikka 11/99, 1999.
- [38] Mäkelin, M. & Vepsäläinen, A. P. J.: *Kilpailu kyvykkyydellä teknologia-, tuotanto- ja markkinointistrategiat*, (2.painos), HM&V Research, 1995.
- [39] Möller, K & Wilson, D. T.: *Business Marketing. An Interaction and Network Perspective*. Klawer Academic Publishers, USA, 1995.
- [40] Niemistö, K.: *Palveluodotukset Lapuan Meritan toimipisteessä*. Seinäjoen liiketalouden ammattikorkeakoulu. Opinnäytettyö, 1999.
- [41] Ohanian, H.: *Physics*, 2nd Ed Expanded, W. W. Norton, 1989.
- [42] Olve, N. G, Roy, J. ja Wetter, M.: *Balanced Scorecard – Yrityksen strateginen ohjausjärjestelmä*. Werner Söderström Osakeyhtiö. Helsinki 1998.
- [43] Pouri, R.: *Businesslogistiikka*. WSOY:n Graafiset laitokset, 1997.
- [44] Prahalad, C. K. & Hamel, G.: *The Core Competence of the Corporation*. Haward Business

- [45] Rangone, A.: *An analytical hierarchy process framework for comparing the overall performance of manufacturing departments.* International Journal of Operation Production Management. P. 104-109, 1997.
- [46] Rentola, I.: *Kemiallisten tekijöiden ja valukoneen kunnon vaikutus teräsaihion pintavikojen syntymiseen.* Dl-työ. Oulun Yliopisto. Prosessi-ja ympäristötekniikan laboratorio, 2001.
- [47] Rope, T. & Pöllänen, J: *Asiakastyytyväisyysjohtaminen.* WSOY, Juva, 1994.
- [48] Saaty, T. L. & Kearns, K. P.: *Analytical Planning – The Organization of Systems.* A. Wheaton & Co. Ltd. Great Britain, 1985.
- [49] Saaty, T.L: *The Analytical Network Process – Decision Making With Dependence and Feedback.* RWS Publications. Pittsburg USA, 1996.
- [50] Salminen, P.: *Ulkoinen vaatimukset.* Logistiikka 1/01, 2001.
- [51] Snyder, A. E. & William, E. Jr.: *Targeting a Company's Real Core Competencies.* Journal of Business Strategy, November/December 1992.
- [52] Sondhi, R.: *Total Strategy.* Airworthy Publications International Limited , Great Britain 1999.
- [53] Spekman, R. E, Lynn, A. I. & MacAvoy, T. C.: *Alliance Competence. Maximizing the Value of Your Partnerships.* John Wiley & Sons Inc, USA, 2000.
- [54] Strategiatiedote, Rautaruukki Steelin Strategia 2001-2005, 2001.
- [55] Takala J, ja Puurunen, H.: *Partnership Between Logistics Company and Food Manufacturer in Finland 2001.* University of Vaasa, 2001.
- [56] Uusi-Rauva, E, Haverila, M. & Kouri, I.: *Teollisuustalous.* Tammer-Paino, Tampere 1993.
- [57] <http://www.outsourcing-research.com/eve-001.pdf> "The Value Model for Outsourcing"
- [58] <http://herkules.oulu.fi/isbn9514265459/isbn9514265459.pdf>
- [59] <http://www.rautaruukki.com/steel>

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