A generic, activity-based Service System Model (SSyst)

This section considers the **activity model** of a generic Service System (SSyst), in an approach derived from the service's lifecycle. It also indicates the interactions between the four stakeholders: *Service provider* (including his suppliers), *Customer*, *Competitors* and *Compliance* bodies (government, legal national and EU service operating framework, authorities).

The SSyst *lifecycle model* includes four main stages:

(1) Customer Order Management,

(2) Service Management,

(3) Service Operations Management, and

(4) Service Taxation and Invoicing.

These stages are mapped onto the four *core service activities*: (a) Design and Development; (b) Delivery; (c) Operations Management; (d) Marketing.

Fig. 1 presents the three perspectives from which the SSyst activity model is further interpreted:

- Core service activities
- Stages of the service lifecycle, and
- Components of the service system activity model.

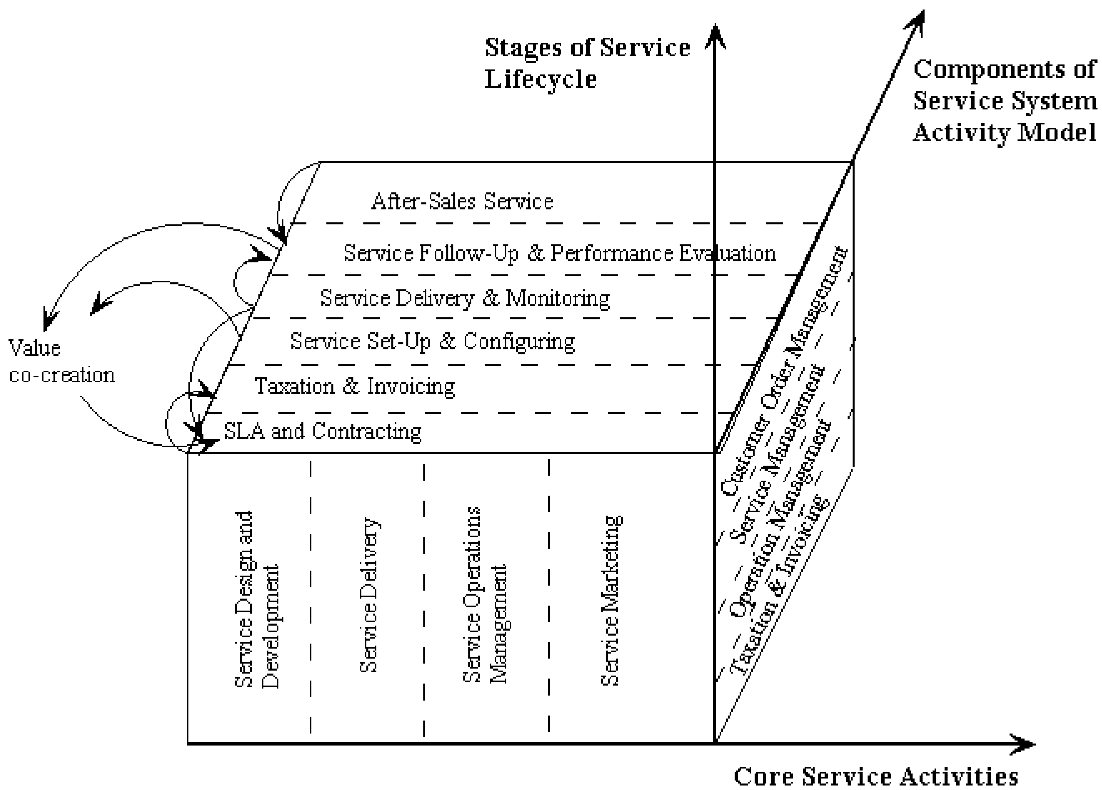


Fig. 1. The three perspectives for the Service System activity model interpretation

1 Development of a generic SSyst activity model

Fig. 2 offers a global representation of the generic service system (SSyst) activity model developed in the thesis framework and the interconnections of its components.

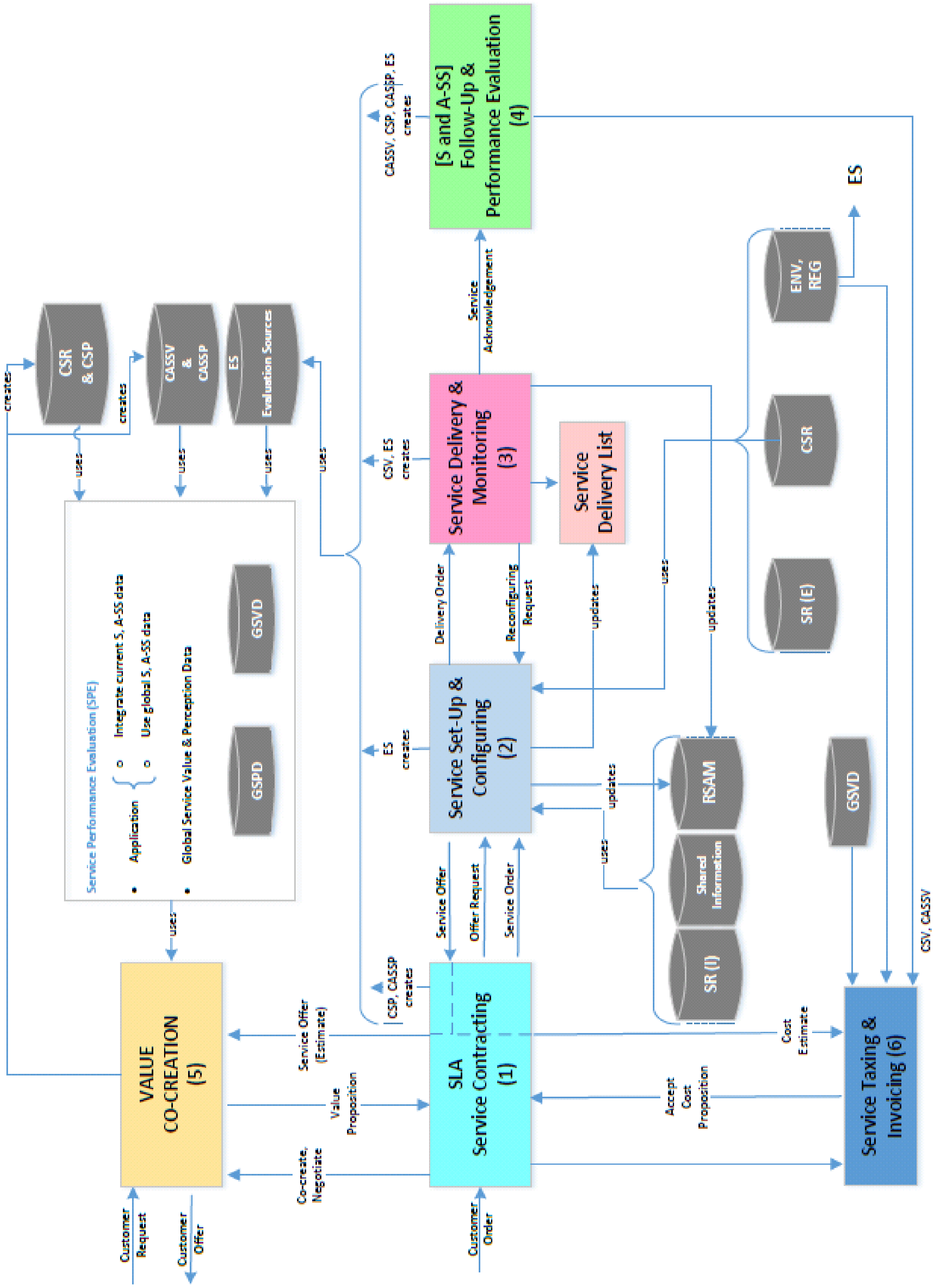


Fig. 2. Global view of the Service System activity model and component interconnection

In the **Customer Order Management** (COM) stage, a Service Level Agreement (SLA) is reached through close interactions between the service provider and the customer. To reach a SLA, the requested service is set up and configured using:

- planning, scheduling and allocation tasks;
- service performance evaluation (SPE) data (relative to available, previously created value and perception data);
- Customer Relationship Management (CRM) strategy and Supply Chain Management (SCM) information;
- comparative evaluation of similar services offered by the competitors;
- compliance constraints imposed by national and EU legal and taxation specifications.

The Service Set-Up and Configuring component, which is called by the SLA component of the COM, is part of the **Service Management** (SM) stage.

Reaching the SLA is done in an iterative and interactive process involving the two main stakeholders, service provider and customer, and the following two types of business items are generated:

- the *registered service contract* (for a pure service or an *after* (product) *sales contract* related to that product), and
- the *invoice*, usually accompanied by a *taxation form*.

The iterative SLA process generates value which is co-created by the service customer – provider interaction, with the primary goal of enhancing the service; the Service Performance Evaluation (SPE) component is extensively used during this process.

From the point of view of the core service activities list (represented in Fig. 1), the Customer Order Management (COM) stage is associated with the Service Design and Development phase (and hence with the SLA and Service Set-Up and Configuring components in the SSyst activity model). Once the SLA is reached, the Service Delivery & Monitoring component is launched during the **Service Operations Management** (SOM) lifecycle stage and it involves two core service activities, namely Service Delivery and Service Operations Monitoring. The service follow-up & performance evaluation activities fall into the **Service Operations Management** (SOM) core activity set.

The Service Performance Evaluation (SPE) activity component selects and uses consolidated data about the particular requested service, i.e.

- value-type data (e.g. quality, cost, timeliness, a.o.) and
- perception-type data (e.g. degree of satisfaction, market share, innovation, a.o.).

This consolidated data is obtained by integrating the value and perception data and information measured and calculated at current service deliveries and post service delivery over the whole history of that particular service offered and repeatedly delivered (and enhanced) by the provider.

Service Marketing *uses specifications* created within the Service Set-Up and Configuring component, value and perception data collected during Service Delivery & Monitoring and Service Follow-up and processed by the Service Performance Evaluation (SPE) component, and it *exploits events* and *strategy* used in the Service Customer – Service Provider interaction process of reaching the SLA.

Based on the analogy with Business Process Modelling (BPM), a business-oriented standardized representation will be created for the SSyst activities model, to allow the definition, stet up and configuring, analysis, and effective simulation of its inter correlated component activities for composite service validation by means on an information system, and the proposal of innovation patterns and solutions.

2 Customer Order Management (COM)

The **Customer Order Management** (COM) stage generates a Service Level Agreement (SLA) during a process of value co-creation. The customer is intensively involved in this process, and he creates value together with the service provider creates value during an interactive, loop-type repeated sequence in which value propositions are formulated and updated until they reach the acceptance of both parties (service provider and consumer).

Value propositions, which include *service specification propositions* and *cost propositions*, are formulated based on:

a) Analysis of customer needs, following the customer’s request;
b) Service Performance Evaluation (SPE);
c) Service set up and configuring.

The SPE process uses consolidated data reflecting the value (cost, performance) and perception (customer satisfaction and attitude, market opportunity, innovation perspective) concerning the requested service to: generate the offer, drive the negotiation strategy and reach finally a SLA. During this process, the service can be enhanced and both parties - customer and provider - will co-create value placing themselves mutually in a win-win relationship.

From the service provider’s side, the value proposition is based on the *service offer estimate* (SO-E), which is created by activating the **Service Configuring and Set-Up** (SCSU) module, part of the Service Management stage of the service’s lifecycle:

- if a *service offer request* (SOR) is received from the customer for an existing, already created service, the SCSU only configures this type of service according to the client's particular request, i.e. delivery time, number of users, necessary resources, etc.
- if a SOR is received for a new, not yet existing service, the SCSU module sets up from zero this service lifecycle progress by:

- creating / setting up new service activities and composing them into the requested service;
- planning the service's activities;
- scheduling the new service's activities and allocating the necessary resources (e.g. equipment, human resources);
- evaluating and proposing the value (cost, specifications) for the resulting new service.

So, on one hand the SPE uses current service value and service perception data (CSV, CSP) and (eventually) current after-sale service value and perception data (CASSV, CASSP) , if the service requested by the customer is integrated in a "*product-service system*" type, such as: "Product-Extension Service" (PES) i.e. after (product) sales service, "*Product-Utility Service*" (PUS) or "*Product-Result Service*" (PRS).

On the other hand, in the value co-creation process upon reaching a SLA, the mutually accepted value proposition updates the CSV and the CSP in the current service databases, (eventually) after negotiations.

The service value data (CSV) collected upon finalizing the SLA is represented by:

- **SCT**: the speed at which customer enquiries are resolved by the SSyst. This indicator is inverse proportional with the time necessary to issue the value proposition VP (provider), the time to negotiate the value proposition VP / iteration, and the number of iterations / value co-creation process;
- **GASC:** the growth of after (product) sales contracts agreed by the client and provider and signed as part of the SLA.

The service perception data (CSP) collected upon finalizing the SLA is represented by:

- **RLSA**: a coefficient indicating the right contractual agreement (SLA) in place;
- **ADCR**: coefficient measuring the adaptability of the service system to the customized client requests.

The value co-creation process (VCo-C) is triggered by the reception of a *customer offer request* generated by a customer. It is assumed that a **Service Repository for External Use** SR(E) is available, that can be accessed by any service requester who can find here information about existing services (this information is published in the SR(E) by the service providers).

This *customer offer request* (SOR) will be answered with a *service offer estimate* (SO-E) which estimates the related costs and confirms the service specifications in reply to the customer's specifications and (eventual) cost proposal.

The specifications related to the service requested by the customer are analysed initially and generate an *offer request* (OR) to the Service Configuring and Set-Up (SCSU) module of the SSyst, responsible with Service Management (Fig. 3).

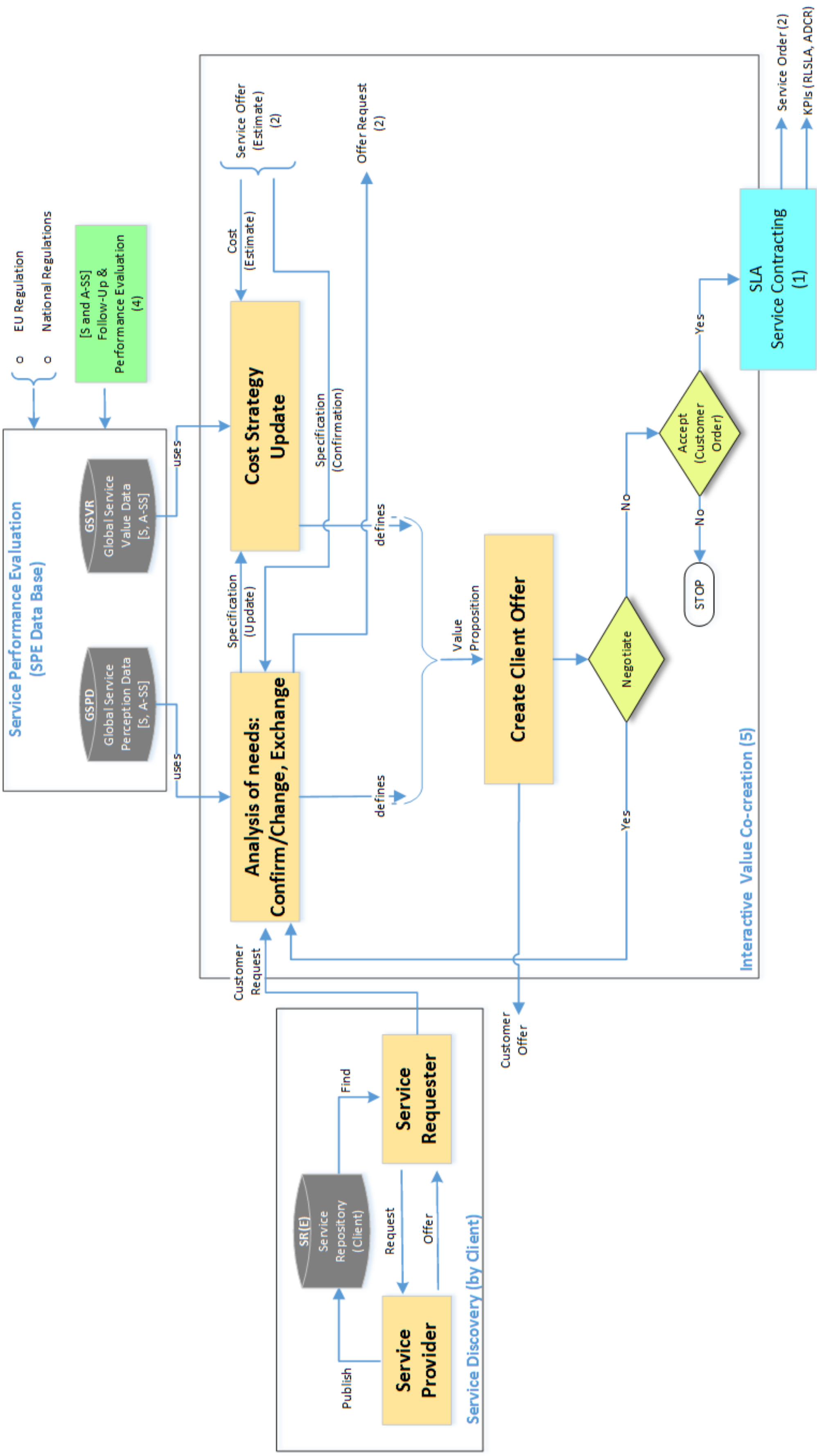


Fig. 3. Service contracting with value co-creation process (VCo-C)

These specifications will be successively compared with the confirmed specifications and cost values calculated by the Service Configuring and Set-Up (SCSU) module (*service offer estimate* SO-E) which updates the provider's specification and cost strategy, in response to the customer's needs in a looped negotiation process during which value is co-created iteratively.

At the end of this negotiation process, successfully terminated with the provider accepting the client's service request and creating the *client offer* (ClO), the customer generates the order (CuO) which allows generating the SLA, by simultaneously contracting the service and finalising the taxation and invoicing processes.

Upon finalizing the SLA - signing the Service Contract and generating the taxation decision and invoice for the customer, a *Service Order* (SO) is also generated to the Service Configuring and Set-Up (SCSU) module, which will consequently update the Resource Service Access Module (RSAM) by specifying now the confirmed allocation and thus the occupancy of the human and technology resources which will be used in the just agreed, registered and invoiced service contract.

A more detailed representation of the iterative value co-creation process (VCo-C) shows in Fig. 4:

(1) the customer actions,
(2) the provider's back office activities - these activities are carried out mainly by the Information System customized for the organization's Service System activity model, and using its databases, and
(3) the customer – provider interactions.

The iterative SLA process features customer – provider interactions from a dual perspective:

(a) Service specifications (options) agreement, and
(b) Cost negotiation, as part of the Service Taxation and Invoicing (STI) component.

The two activity components (SLA and STI) realize the customer – provider interaction in a dual negotiation activity (service specification / cost) controlled in parallel by two strategies:

- Analysis of customer needs (service specification strategy update), and
- Cost strategy update for agreed service specifications.

These strategies are repeatedly run in the provider's back-office, where the two activity components (SLA and STI) receive the most recent updates from the interacting components: SLA receives service cost updates from the STI whereas STI receives service specification updates from the SLA.

During this iterative, combined negotiation process, the initial service specification confirmations and cost estimate (produced in the back-office by the Service Configuring and Set-Up component) are eventually updated, considering the global perception data (in the GSPD database) and global value data (in the GSVD database) for the requested service.

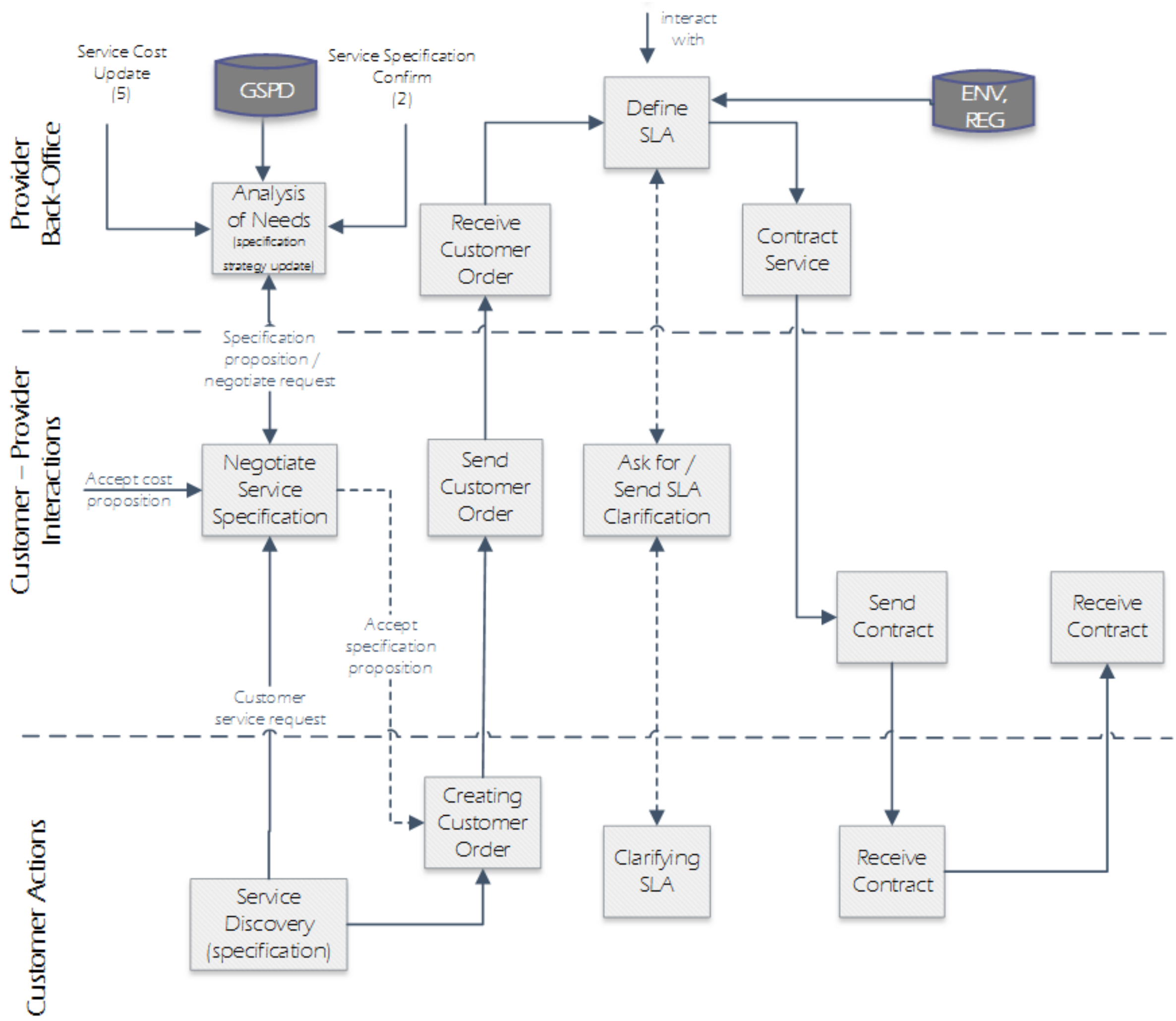


Fig. 4. Interactive value co-creation, SLA and service contracting

These data were created during the history of delivering the requested service, weighted by the current market and compliance (legal, financial) context.

So, the value proposition, as output of the value co-creation process, is derived from the current service specification proposition AND the cost proposition. When both of these two propositions are accepted by the customer AND the provider, the service order (SO) sent by the client to the provider will trigger the definition of the SLA, subject to:

- an interactive clarification process involving the customer and the provider, and
- a consulting process about environmental (context) and compliance (legal, financial constraints) conditions (using the ENV, REG databases).

The SLA ends by registering the Service Contract.

3. Service Taxation and Invoicing (STI)

At the same time with registering the service contract, the taxation forms are created and eventually reviewed in an interactive customer - provider clarification process, followed by the invoice calculation. Both the taxation decision and the invoice are addressed to the customer.

Fig. 5 depicts the service taxation and invoicing activities. This SSyst activity component interacts not only with the SLA and the Service Contracting component, but also with the Service Follow-Up & Performance Evaluation (SPE) activities, for possible reimbursement.

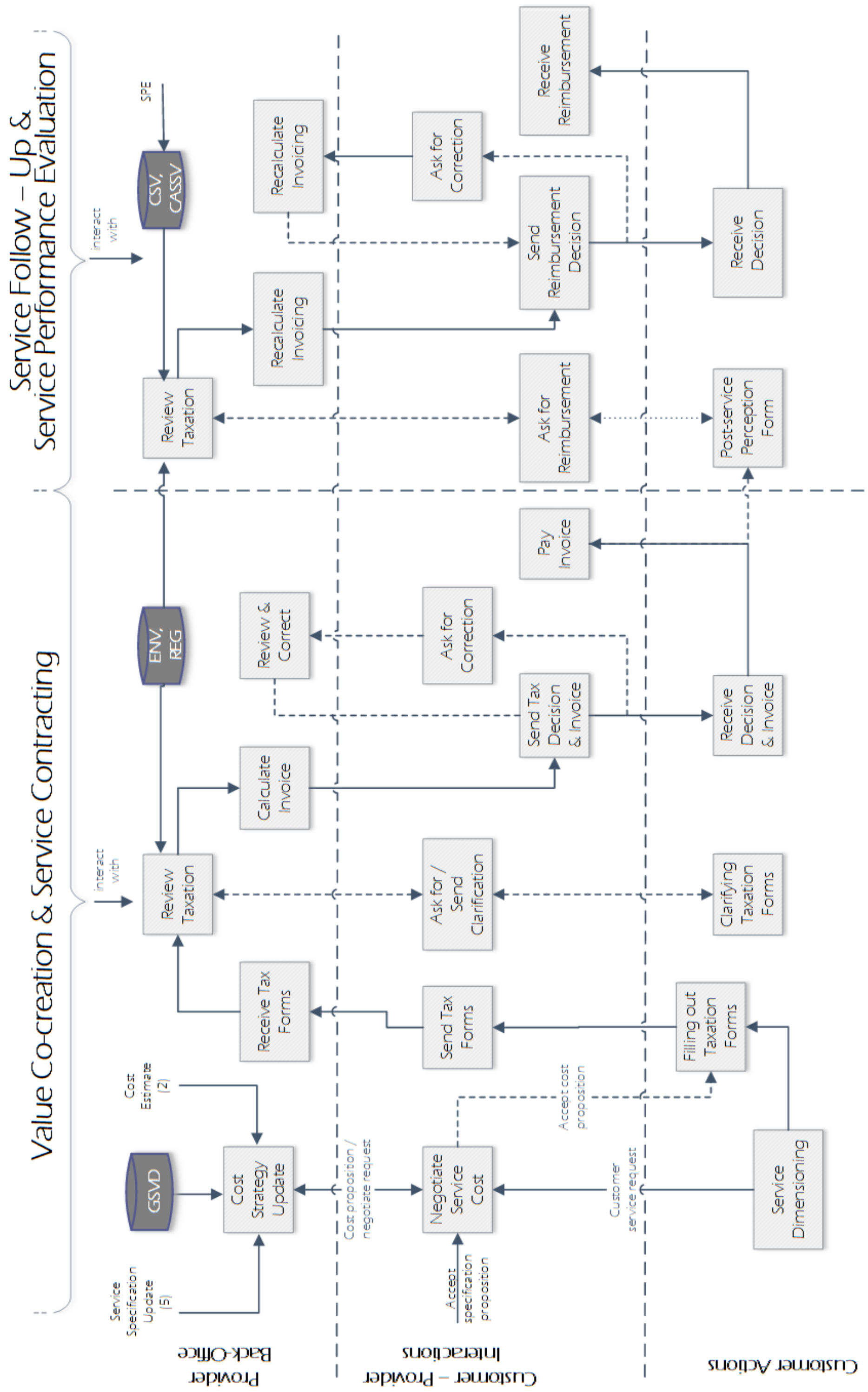


Fig. 5. Service Taxation and Invoicing component (STI) in the SSyst activity model

In the special case when some service components were not delivered due to some reason (provider's fault, environmental conditions or changes) the invoice may be recalculated and a reimbursement decision issued.

At the provider's back-office level, the review of the service taxation is accepted on the basis of checking the current service value data, service delivery status, exceptions and alarms which may have triggered service reconfiguring requests. This information and related data are available being stored in the Current Service Value (CSV) database, respectively in the Current After-Sales Service Value (CASSV) database, updated during service delivery.

The most intensive STI interaction between the customer and the service provider takes place during the negotiation process for acceptance of the cost proposition relative to a mutually agreed service specification proposition. One perception-type KPI that can be generated at the termination of the STI and SLA processes is ADCR - pointing at service system agility.

4 Service Management

In the service lifecycle analysis, the **Service Management** stage corresponds to the **Design and Development** core service activity, being covered by the **Service Configuring and Set-Up** (SCSU) component of aggregate activities. This component of the proposed generic Service System Activity Model is represented in Fig. 6.

The SCSU component of aggregate activities is activated in one of the following stages:

- When *a service offer is requested* (SOR) to reach the SLA: in this situation, depending on the (partial) availability of the (composite) service, on the customization requirements and on the environmental constraints, the requested service is planned, its activities are scheduled and for each activity capacities and resources (technological, human) are allocated. The feasibility of the resulting service specifications and cost is evaluated with respect to the competitors and a decision of eventually renting some resources / outsourcing some services is taken; the *Service Offer Estimate* (SO-E) is finally issued and sent both to the **SLA & Service Contracting** component and to the **Service Taxation and Invoicing** component for (eventual) negotiation with the customer. If, during this negotiation process, the customer changes the service specifications, the SCSU application is run again and produces a new SO-E in response to the client's modified preferences.
- When a *Service Reconfiguring Request* (SRR) is received during service delivery: in this situation, depending on the resource (technological) failure or (human) unavailability or on the execution context, the service is re planned or reconfigured at an extent of coverage depending on its current degree of accomplishment, quality and timeliness. If, for any reason, the execution of the SCSU Service Management stage refutes the feasibility in the given context, the Current Service Value (CSV) and Current After Sales Service Value (CASSV) databases are updated in order to allow

the acceptance of the customer's reimbursement request and review the service taxation for effective reimbursement.

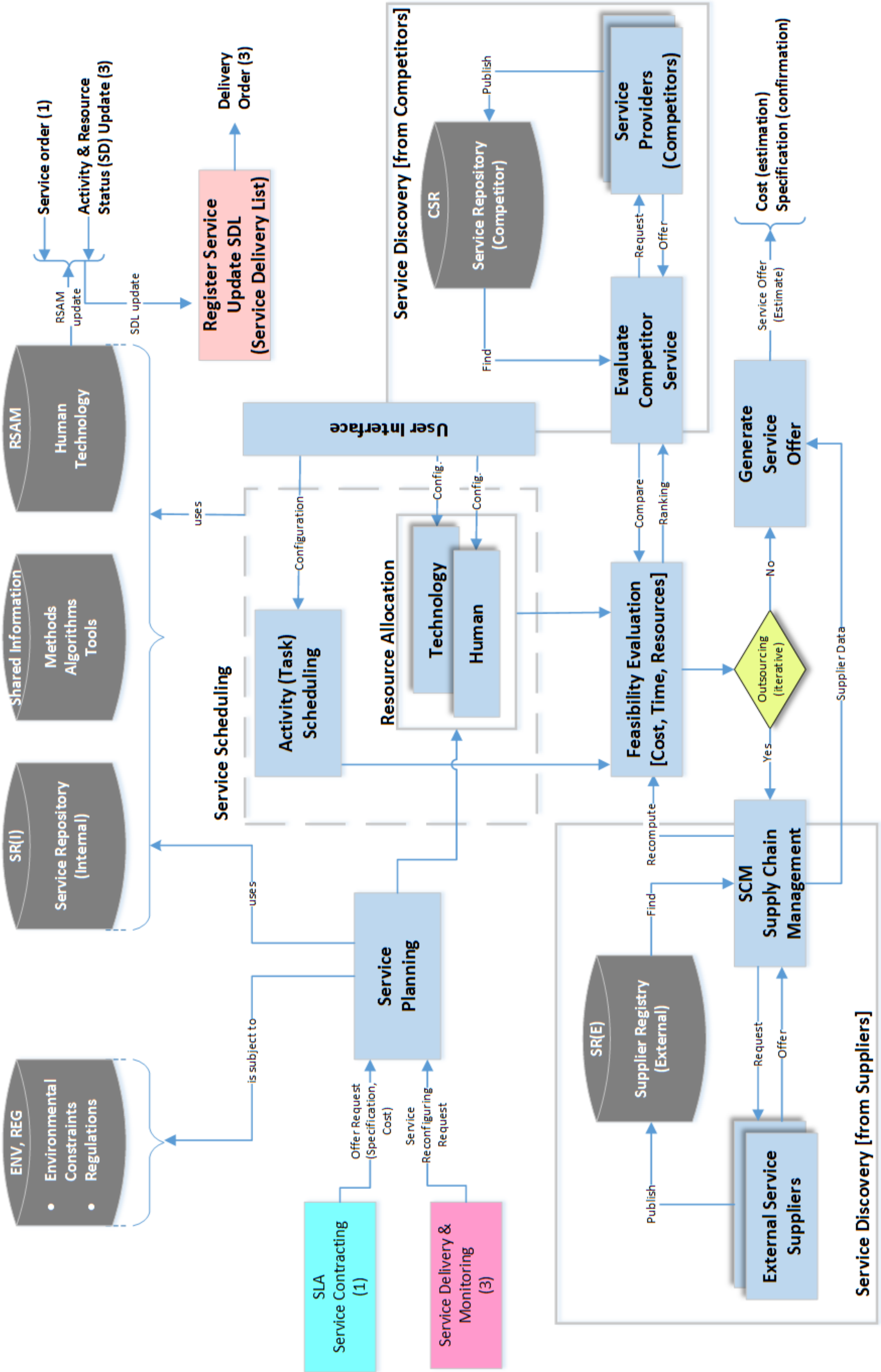


Fig. 6. Service Configuring and Set-Up component (SCSU) in the SSyst, used to design, develop and reconfigure a service in the **Service Management** lifecycle stage

- When (a) a *Service Order* (SO) is received as a consequence of value proposition [service specifications + cost] accepted by the customer, SLA defined, taxation clarified, service contract registered and invoice issued or (b) when a *Service Reconfiguring Request* (SRR) is received and a feasible new service scheme is computed: in this situation, the ordered / reconfigured service is registered and a Service Delivery List (SDL) is created by specifying all the activities of the (composite) service and their execution time periods. Also, the occupancy of capacities and resources (human, technological) is effectively marked in a Resource Service Access Management (RSAM) database.

The core activities involved in the SCSU Service Management stage are: (i) **service planning** and (ii) **service scheduling**, which assumes *activities scheduling* and *resource* (human, technology) *and capacity allocation*.

These operations are computed by the Information System implementing the SSyst activity model, which uses the following data bases:

- *Service Repository* (*Internal*), SR(I): a list of available services, which can be delivered by the provider, and thus can be directly included in larger, composite services; all their specifications are included in the SR(I) database.

- *Shared Information*: a complete set of strategies and methods for service planning, matching capacity and demand and also a set of algorithms and tools to be used for service activities sequencing and resource allocation.

- *Compliance and Environmental Constraints*, REG, ENV: define the legal execution context in which services can be delivered, resources and capacities used, and the financial frame in which services are subject to taxation.

- *Resource Service Access Management*, RSAM: a complete list of the available resources and capacities, their occupancy in time, quality and timeliness of already provided services (per service type and cumulated), operating status, consumption per service (fuel, power, a.o.), time to maintenance. This information is updated globally whenever: (a) a new service is ordered (following the registration of a contract) or re planned / rescheduled (following a service reconfiguring request) and (b) a service is completely delivered, respectively periodically during service delivery.

- *Service Delivery List*, SDL: a list reflecting the delivery status of all activities composing all ordered services; exceptions are also registered in the SDL whenever unforeseen events occur during the execution of a service activity.

The current execution of a service activity or entire (composite) service is a permanent challenge because the objectives of the organization, the needs of the customer, and attention paid to service / resource suppliers and competitors must be all managed simultaneously in a dynamic, permanently changing environment and more and more global market.

4.1 Service planning

Service planning consists in assigning the necessary time interval and capacity corresponding to the service specifications requested by the customer and agreed in the SLA; these specifications may refer, in the most general case, to the number of users for which a simple (1-activity) or composite (n-activity, $n \geq 1$) service is requested and its delivery must be started at a certain moment of time or must be finished at a certain moment of time for all users. We shall refer to such task as "service set", with $\dim(service\_set) = n$, and

$$delivery(service\_set) = \begin{cases} t_{start\_delivery}, & start\ imposed \\ t_{finish\_delivery}, & termination\ imposed \end{cases}$$

The service planning function of the SCSU is related to matching capacity and demand; several strategies and methods have been selected and included in the Shared Information repository. **Chase demand** and **level capacity** and are two generic strategies proposed for service planning. For the chase demand strategy, a number of operations-oriented strategies such as *workshift scheduling* to vary capacity to match the changing levels of customer demand are proposed. For the level capacity strategy, marketing-oriented strategies are proposed, such as *price incentives* that can smooth customer demand to utilize better fixed capacity. **Yield management**, a hybrid strategy using real-time information systems to maximize revenue is also considered.

Finally, in the idea of allowing the analysis of rush orders received from the customer, the **Early Deadline First** (EDF) strategy is included in the Shared Information repository as planning mechanism sets of service, i.e. identical (composite) services ordered for groups of customers.

□ **Strategies for demand management**

Chase demand is a generic strategy for managing demand, providing moderate customer waiting for a short-running forecasting, and being characterized by: high utilization of employees having a low labour-skill level and for whom low training is necessary, high supervision is required in conditions of high labour turnover.

Several strategies are available in the *Shared Info methods* repository for managing demand when a level capacity is being maintained:

Managing Customer-Induced Variability

There have been considered five sources of customer-induced variability in service arrival rates/operations, for which the service management should match capacity with demand:

- *Arrival variability*: independent decisions of customers seeking service are not evenly spaced in time;
- *Capability variability*: is due to the level of customer knowledge, physical ability, and skills;
- *Request variability*: results from the unique demands of customers that create uneven service times;

- *Effort variability*: when customers are expected to perform a role in a service interaction, the level of commitment results in effort variability;
- *Subjective preference variability*: results from the fact that the expectation of what it means to be treated well varies among customers.

Two strategies for managing customer-induced variability are proposed to be selected from the strategy repository and used for managing customer-induced variability:

1. Accommodation strategy: favours customer experience over operational efficiency.
2. Reduction strategy: favours operational simplicity over service experience.

Combining 1 and 2, creative hybrid strategies that give customer a choice could provide operational simplicity without compromising service experience. Table 1 outlines proposed strategies to manage customer-induced variability.

Table 1. Strategies for managing customer-induced variability

Type of Variability	**Accommodation**	**Reduction**
Arrival	Provide generous staffing	Require reservations
Capability	Adapt to customer skill level	Target customers based on capability
Request	Cross-train employees	Limit service range
Effort	Do work for customers	Reward increased effort
Subjective preference	Diagnose expectations and adapt	Persuade customers to adjust expectations

Segmenting Demand (Segmentarea cererii)

Demand for a service seldom derives from a homogeneous source; often, demand is grouped into random arrivals and planned arrivals. While demand is not controllable, appointments are, for certain types of services (e.g. in the healthcare system, car service, a.o.). The Segmenting Demand strategy uses historical data about service demand over a longer past period of time (e.g. one year), and subtracts the daily accepted requests from daily service capacity to obtain the number of appointments (engagements) which are needed each day to *smooth demand*. The daily smoothing of demand can be further refined by scheduling appointments at appropriate times during the day.

Offering Price Incentives (Ofertarea de preturi motivante)

This strategy consists of differential pricing with respect to a number of patterns identified from the previous *experience* of service delivery. A number of such experiences is first defined, by clustering the recorded data about services delivered over a sufficiently long period of time (year, season, month, week, day) for that class of services. This data is used to develop a demand curve for each experience type, and from it the *discriminatory service prices*. Discriminatory pricing fills in the valleys (i.e. periods of low demand) rather than leveling off the peaks.

Promoting Off-Peak Demand (promovarea cererii in afara varfului de comenzi)

The creative utilization of off-peaks capacity consists in seeking different sources of demand. The strategy of promoting off-peak demand can be used to discourage overtaxing the facility at other times when the demand increases (e.g. telephone companies offering unlimited calling on week-ends, when the network is underutilized, utilization of a resort hotel during the off-season as a retreat location for business or professional groups).

Developing Complementary Services

Complementary services are offered to *occupy waiting consumers*. The strategy of developing complementary services is a natural way to expand an organization's market, and is particularly attractive if the new demands for service are contracyclical and result in a more uniform aggregate demand (i.e. when the new demand is high, the original service demand is low (Fitzsimmons, 2011)).

Reservation Systems and Overbooking

Taking reservations *presells the potential service*. As reservations are made, additional demand is deflected to other time slots at the same facility or to other facilities within the same organization. Reservations benefit consumers by *reducing waiting* and *guaranteeing service availability*. Problems do arise, however, when customers fail to honor their reservations (no-show).

In order to hedge against significant number of no-shows, companies may adopt a strategy of *overbooking*, i.e. accept reservations for more than the available capacity. A good overbooking strategy should minimize the expected opportunity cost of idle service capacity as well as the expected cost of turning away reservations. Thus, adopting an overbooking strategy requires training frontline personnel to handle graciously customers whose reservations cannot be honoured.

□ **Strategies for capacity management**

Level capacity is a second generic strategy for capacity management, providing generally low customer waiting for long-run forecasting, and being characterized by: moderate utilization of employees having a high labour-skill level and for whom high training and low supervision is necessary; there is also low labour turnover.

Service capacity is defined in terms of an achievable level of output per unit time (e.g., transactions per day for a busy bank clerk). It is to be noted that for a service provider the measure of capacity is based on a *busy employee* and <u>not</u> on observed output that must always be less than capacity. However, service capacity can be also defined in terms of the supporting facility (e.g., number of hotel beds); capacity can be limited by several factors such as: available labour by skill classification, equipment, environment.

For many services, demand cannot be smoothed very effectively; therefore, control must come from adjusting service capacity to match demand. Several strategies are proposed to achieve this goal.

Daily Workshift Scheduling

By scheduling workshifts carefully during the day, the profile of service capacity can be made to approximate demand. Workshift scheduling is an important staffing problem for

many service organizations that face cyclical demand (e.g. telephone companies, banks and police departments, etc.).
The following approach is proposed to implement a daily workshift scheduling: (1) begin with a forecast of demand by hour, (2) which is converted to hourly service staffing requirements (the time interval could be less than one hour for certain types of services). Next, (3) a schedule of tours, or shifts, is developed to match the staffing requirements profiles as closely as possible. Finally, (4) specific service personnel are assigned to tours, or shifts.

Weekly Workshift Scheduling with Days-Off Constraints

Developing tours to match the profile of daily demand is only one part of the planning and resource allocation problem. Many public services must be available 24 hours a day, every day of the week. For such organizations, a typical employee works 5 days a week with 2 consecutive days off the week, but not necessarily Saturday and Sunday. In the Service Management stage the objective consists in developing work schedules and meeting the varying employee requirements for weekdays and weekends with the smallest number of staff members possible.

This problem is formulated as an *integer linear programming* (ILP) model.

(1) The desired staffing levels are first calculated for each day in ther week.

(2) The problem then becomes one of determining the minimum number of employees required for assignment to each of seven possible tours. Each tour consists of 5 days on and 2 consecutive days off; each will begin on a different day of the week and last for 5 consecutive working days.

The general formulation of this problem as an IL model is:

Definition of variables:

x_i = number of employees assigned to tour *i*, where day *i* begins 2 consecutive days off (e.g., employees assigned to tour 1 have Sunday and Monday off)

b_j = desired staffing level for day *j*

Objective function:

Minimize $\sum_{i=1}^{7} x_i$

Constraints ($x_i \geq 0$ and integer)

Sunday	$x_2 + x_3 + x_4 + x_5 + x_6 \geq b_1$
Monday	$x_3 + x_4 + x_5 + x_6 + x_7 \geq b_2$
Tuesday	$x_1 + x_4 + x_5 + x_6 + x_7 \geq b_3$
Wednesday	$x_1 + x_2 + x_5 + x_6 + x_7 \geq b_4$
Thursday	$x_1 + x_2 + x_3 + x_6 + x_7 \geq b_5$
Fruday	$x_1 + x_2 + x_3 + x_4 + x_7 \geq b_6$
Saturday	$x_1 + x_2 + x_3 + x_4 + x_5 \geq b_7$

Increasing Customer Participation

The strategy of increasing customer participation allows ellimination of personnel doing part of their tasks related to services (e.g. the customer places the order directly from a limited menu, clears the place after the service is performed, etc.). Naturally, the customer expects faster service and cost reduction to compensate for his help, and the service provider benefits in many subtle ways:

- there are *fewer personnel to supervise and to pay*, and more important
- *the customer* as a coproducer *provides labour just at the moment it is required*.

Thus, capacity to serve varies more directly with demand rather than being fixed. Some drawback to self-service do exist, because the quality of labour is not completely under the service manager's control.

Creating Adjustable Capacity

Through design, a portion of capacity can be made variable (e.g., arrangement of workplaces where services are delivered). Capacity at peak periods can be expanded by the effective use of slack times. Performing supportive tasks during slower periods of demands allows employees to concentrate on essential tasks during rush periods. This strategy requires some cross-training of employees to allow performance of noncustomer-contact tasks during slow-demand periods.

Sharing Capacity

A service delivery system often requires a large investment in equipment and facilities. During periods of underutilization, it may be possible to find other uses for this capacity (inclusively by leasing the resources).

Cross-Training Employees

Some composite service systems are made up of several operations. When one operation is busy, another operation sometimes may be idle. Cross-training employees to perform tasks in several operations creates flexible capacity to meet localized peaks in demand. Assigning temporarily a different job to employees can help *building an esprit de corps* and give employees *relief from monotony*.

Using Part-Time Employees

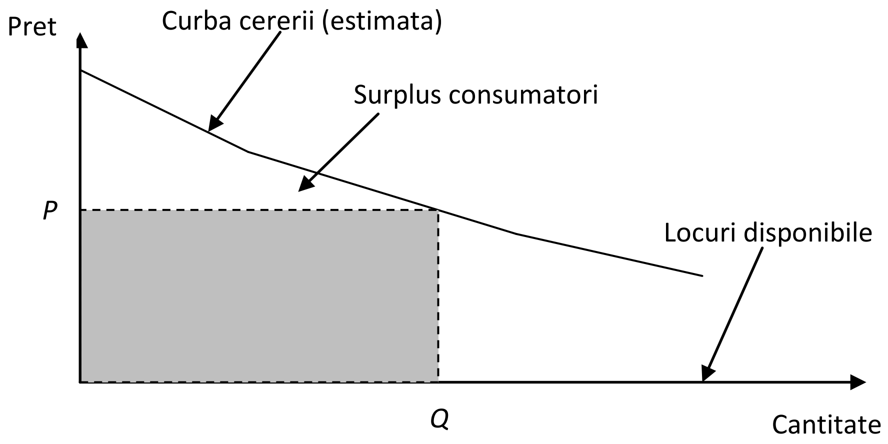
When peaks of activity are persistent and predictable, part-time help can supplement regular employees. Sources of part-time help are: (i) high school or college students as well as others who are interested in supplementing their primary source of income, if the required skills and training are minimal; (ii) off-duty personnel who are placed on standby, when the required skills and training are consistent.

□ **Yield management**

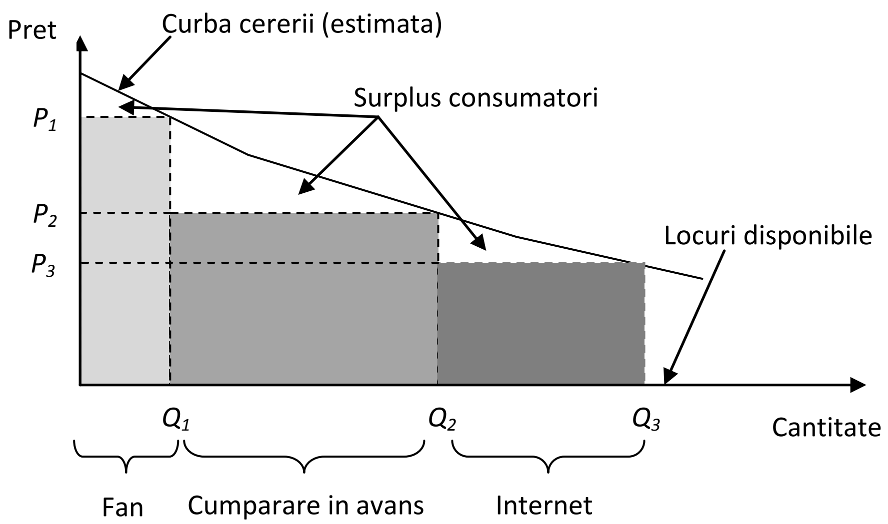
Yield management, a new approach to revenue maximization, is a comprehensive planning mechanism that incorporates many of the strategies presented earlier in this section (e.g., using reservation systems, overbooking, and segmenting demand).

Because of the perishable nature of theatre seats (i.e., once a play has begun, the potential revenue from an empty seat is lost forever) offering a *discount on fares to* fill the theatre hall becomes attractive. Selling all seats at a discount, however, would preclude the possibility of selling some at full price. Yield management attempts to allocate the fixed capacity (of seats on a play) to match the potential demand in various market segments (e.g., occasional fan, regular purchaser, supersaver) in the most profitable manner.

The economic motivation behind yield management is shown in Fig. 7a - an illustration of princing a seat for a theatre play. This figure illustrates the traditional *fixed price relationship* between a downward sloping demand curve and quantity sold. In this situation, provided Q is less than or equal to the seatrs available, the total revenue for the play is P (price) x Q (quantity of seats sold) = PQ. The typical result is empty seats and a large consumer surplus (many spectators willing to spend considerably more for the theatre play than the fixed price).



a. Pret fix traditional; venituri totale = $P \times Q$



b. Pret multiplu utilizand *yield management*; venituri totale = $P_1Q_1 + (Q_2 - Q_1)P_2 + (Q_3 - Q_2)P_3$

Fig. 7. Stabilirea pretului locurilor pentru un spectacol intr-o sala de teatru

Fig. 7b indica aceeasi curba a cererii cu preturi diferite pentru trei segmente de piata: P_1 pentru fani, P_2 pentru cumparare in avans, si P_3 pentru achizitie prin Internet. Un numar mic de spectatori sunt dispusi sa plateasca un pret premium pentru "fan total" deoarece biletul poate fi cumparat la orice ora si este in intregime rambursabil. Biletele achizitionate in avans trebuie cumparate cu 14 zile inainte de spectacol si nu sunt rambursabile. Internet special este un bilet electronic nerambursabil disponibil pe web site-ul teatrului ori de cate ori se estimeaza ca spectacolul nu va fi cumparat in totalitate (o oportunitate de a vinde locuri suplimentare cu o reducere).

Strategia yield management este adecvata pentru firme de servicii care se caracterizeaza prin:

- *Capacitate relativ fixa*: firmele de servicii cu o investitie substantiala in facilitati (de ex. domeniul hotelier, liniile aeriene) pot fi considerate ca avand capacitate restrictionata.
- *Abilitate de a segmenta piata*: pentru ca strategia yield management sa fie efectiva, o firma de servicii trebuie sa fie capabila sa isi segmenteze piata sa in diferite clase de clienti (de ex. clienti sensibili la afaceri (eficienta), clienti sensibili la pret (economie), etc.). Dezvoltarea de diferite clase de servicii diferentiate ca pret reprezinta o *provocare de marketing* pentru o firma care utilizeaza strategia yield management.
- *Inventar perisabil*: pentru firme de servicii avand capacitate restrictionata, fiecare capacitate atomica care asigura un serviciu (de ex. loc, camera, etc.) este referita ca *o unitate de inventar* ce trebuie vanduta (sau inchiriata). Venitul de la o unitate nevanduta este pierdut definitiv. De aceea, politica de acordare a unui bilet de spectacol gratuit pentru spectator fidel / bilet de avion gratuit pentru un pasager care zboara frecvent la un spectacol care nu se joaca cu casa inchisa / pentru un zbor care nu este complet ocupat nu incumba nici un fel de cost pentru firma.
- *Produs vandut in avans*: sistemele de rezervare sunt adoptate de firme de servicii pentru a vinde capacitati inainte de utilizare; totusi, exista incertitudinea acceptarii unei rezervari timpurii la un pret redus sau asteptarii speranta vanzarii unitatii de inventar unui client dispus sa plateasca mai mult. Solutia consta in utilizarea unui *grafic de control al cererii* intocmit pe baza rezervarilor facute in trecut (la nivel de saptamana, luna, sezon, etc.). Deoarece sunt de asteptat variatii in cerere, este trasata o gama acceptabila (de ex. ± 2 deviatii standard) in jurul curbei cumulate de rezervari estimate:
    - Daca cererea reala este mai mare decat cea estimata, clasele de sercii de cost redus sunt inchise si nu sunt acceptate decat rezervari la cost standard.
    - Daca acumularea rezervarilor scade sub limita acceptabila in domeniul definit, atunci sunt acceptate rezervari de unitati de inventar la cost redus.
- *Cerere fluctuanta*: utilizand previzionarea cererii, strategia yield management permite managerilor sa creasca gradul de utilizare a capacitatii pe perioadele de cerere redusa si sa creasca veniturile pe perioadele de cerere inalta. Controland disponibilitatea costurilor reduse, poate fi maximizat venitul total pentru un serviciu cu restrictii. Strategia yield management este implementata in timp real deschizand si/sau

inchizand sectiuni rezervate - la orice perioade de timp, chiar si la nivel de o ora daca dinamica cererii o impune.

- *Costuri reduse ale vanzarilor marginale si costuri marginale inalte ale schimbarilor de capacitati*: costul vanzarii unei unitati de inventar aditionale trebuie sa fie redus, in timp ce costul marginal al extensiilor de capacitate este inalt datorita investitiilor necesare pentru facilitati

4.2. Managing rush orders

Because of the similarities between a task run on a processor and a *service set* (a set of identical (composite) services ordered for a number of persons) delivered with a service capacity (a number of facilities) - both are preemptive, independent of other tasks or service sets, have a release, a delivery date and an fixed or limited interval in which they are processed -, the **Earliest Deadline First** (EDF) procedure is proposed to schedule new service sets (*rush orders*) for a given capacity of a service provider.

Earliest Deadline First (EDF) is a dynamic scheduling algorithm generally used in real-time operating systems for scheduling periodic tasks on resources, e.g. processors (Sha et al., 2004, Lipari, 2005). It works by assigning a unique priority to each task, the priority being inversely proportional to its absolute deadline and then placing the task in an ordered queue. Whenever a scheduling event occurs the queue will be searched for the task closest to its deadline. A feasibility test for the analisys of EDF scheduling was presented in Liu and Layland (1973); the test showed that under the following assumptions:

(A1) All tasks are periodic, independent and fully preemptive

(A2) All tasks are released at the begining of the period and have deadlines equal to their period;

(A3) All tasks have a fixed computation time or a fixed upper bound which is less or equal to their period;

(A4) No task can voluntarily stop itself;

(A5) All overheads are assumed to be 0;

(A6) There is only one processor, a set of *n* periodic tasks can be scheduled if

$\sum_{i=1}^{n} C_i / T_i \leq 1$; n = number of tasks; C_i = execution time; T_i = cycle time, or, in other words, if the utilization of the processor (resource) is less than 100%.

A service set list is composed of raw orders (list of identical services to be delivered to groups of people); this is why two different service sets are independent. Nevertheless, there is a difference between a task and a set of services: a task is periodic while a service set is generally aperiodic.

This means that insted of testing the feasibility of assigning service sets to the service capacity (provider) considering the equation above, one can use the following test: "for an ordered queue (based on delivery date) of n service sets with computed execution periods $exec\_per$, if $\sum_{j=1}^{i} exec\_per_i \leq delivery\_date_i, 1 \leq i \leq n$, then the service sets can be assigned to the service capacity using EDF without passing over the delivery dates, (Tanaya et al., 1995).

This EDF approach is used to insert rush orders in a capacity in which services were already scheduled by the Service Configuring and Set-Up component (SCSU) in the Service Management stage, using available planning strategies matching demand with capacity; the steps below are carried out for inserting a new service set (rush order) during the execution of an already planned sequence of service orders (see Fig. 8):

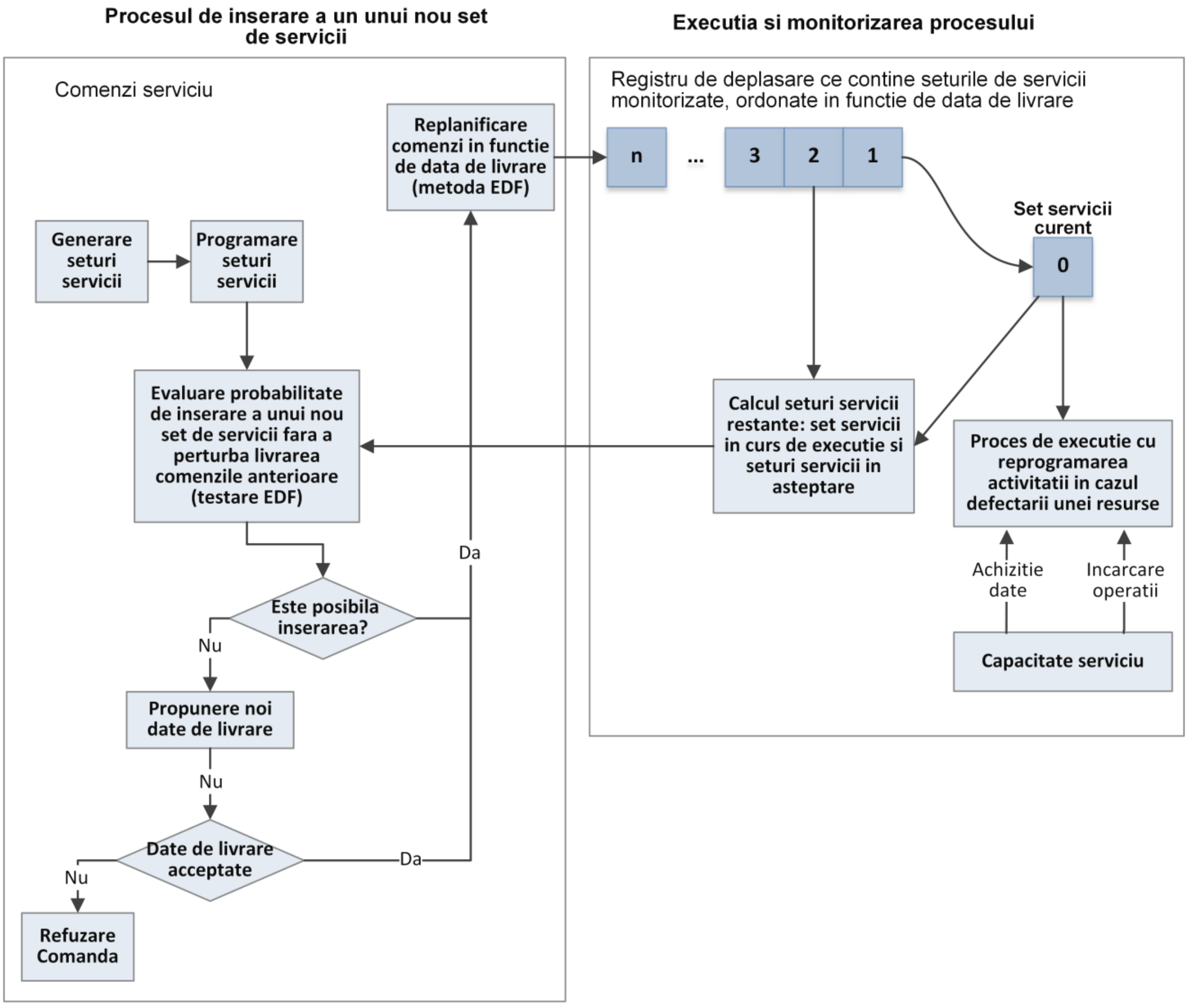


Fig. 8. Rush order diagram and integration with service planning and capacity insertion

0. Compute the remaining time for finishing the rest of the current service set (if necessary).
1. Insert new service data: service type, number of customers (dimension of the people group), delivery dates.
2. Separate services according to their delivery date.
3. Form the entities "Service sets" (a service set is composed of all the services having the same delivery date).
4. Generate raw orders inside the composite service sets (aggregate service lists).
5. Schedule the raw orders (using a planning algorithm, e.g. Yield Management), compute the execution time and test if the inserted service set can be done (the execution time is smaller than the time interval to delivery date if the service starts now).
6. Analyze the possibility of allocating the service sets to the service capacity using the Earliest Deadline First procedure and second equation for feasibility test.
7. Allocate the service sets on the real-capacity system according to the EDF procedure.
8. Resume execution process with new scheduled orders.

In this mechanism for the management of changes in service orders, an *inserted service set* is a service set that arrives while another one is in execution. A *monitored service* set is one whose orders are scheduled and assigned to the service capacity (it has a priority and is waiting to enter execution). A *current service set* is the one in execution.

The capability of adding rush orders to service delivery needs a new entity, the **service set**. In this way job scheduling is done at service set level (all orders with the same delivery date are scheduled together) and then service sets are assigned to the capacity according to their delivery date, using the EDF procedure. Because the process of service set execution is interruptible (preemptive system), new service sets (rush orders) can be introduced exactly at the moment of their arrival.

The insertion process is triggered by the arrival of a "new order" event; a real-time acceptance response can be provided (via the ERP level) to the customer if the rush order can be executed by the requersted delivery date.

5 Operations Management

The Operations Management stage of a service's lifecicle involves two core service activities: **Service Delivery** and **Service Operations Monitoring**, which are represented in Fig. 4.11.

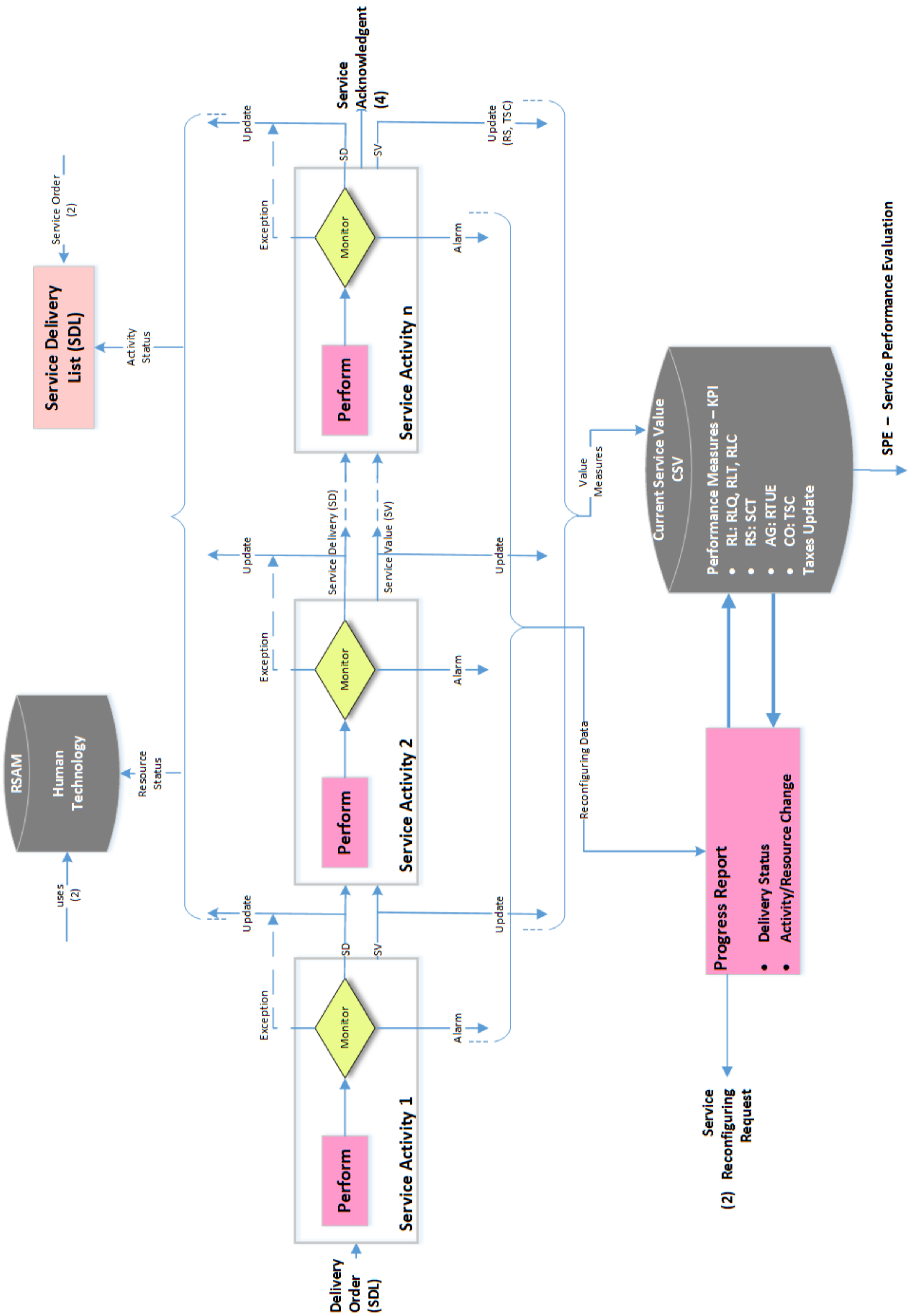


Fig. 8. Service Delivery & Monitoring Component in the SSyst activity model

In addition, while monitoring service operations a number of *value measures* are performed (timeliness, quality, cost - reflecting the service value, SV), which are stored in the Current Service Value database (CSV) for the service being currently delivered:

- *Reliability* (RL), the value of the Service System to answer right the customer needs:
    - RLQ: *quality* of the service - appreciation collected from the customers at several delivery stages (including the final one) of a composite service about the standards at which the service was delivered
    - RLT: *timeliness* of the performed service (reflects all delivery stages of a composite service)
    - RLC: *consistency* of the service (reflects the way in which the delivered service answers the client's requirements)
- *Responsiveness* (RS), the speed at which the client's requests were resolved by the Service System:
    - SCT: the measured *service cycle time* (per activity, and per total composite service)
- *Agility* (AG), the *reaction speed* of the Service System *to respond to market changes* to maintain / gain competitive advantage - statistical data introduced by the provider's staff combined with data collected from customers, and with statics data from the service market (about competitors) and the delivery environment (new parameters, rules, directives, laws and application instructions)
    - RTUE: *reaction time to unplanned events*, this data is partially collected during service delivery
- *Cost* (CO), the cost reported by the provider's departments while operating the Service System to effectively resolve customer requirements:
    - TSC: partial service costs measured during delivery stages and finally aggregated to evaluate *total service costs*

In parallel with service delivery, the financial data about *taxes update* is also collected, for post-service delivery analysis.

The Current Service Value (CSV) data thus reflects the value of the service at different delivery stages; this data is gathered, primarily processed and used, after completion of the service delivery, for **Service Performance Evaluation** during the **Service Follow-up** activity of the **Operation Management** post-service stage.

The management of the delivery and monitoring operations represented in Fig. 8 is designed for the most general case of composite services, which feature a number of $n \geq 1, n \in \mathbf{N}$ activities. These activities have been planned and scheduled in an optimal manner relative to the customer's requirements in the Service Configuring and Set-up (SCSU) module of the Service Management stage.

During each Activity i, $1 \leq i \leq n$, a task (or job) is performed and monitored; at the end of each task two types of data are collected (directly measured or introduced manually by the operator of that current activity):

1. Data about *service delivery* (SD):

   - *Resource status*: status of the resources used, degree of occupancy of the human resource, technological resource and service capacity. This data updates the status of the technology and HR in the global database of the service provider: *Resource Service Access Management* (RSAM);
   - *Service delivery status*: current status of delivery for the composite service, after completion of the current activity i, $1 \leq i \leq n$.

2. Data about *service value* (SV):

   - Value measures about the *quality* and *cost* of the currently performed activity *i*, $1 \leq i \leq n$

The monitoring activity during service delivery generates two other types of information in case of abnormal events occurring while performing the current activity *i*:

- *Exceptions* with respect to normal service delivery while performing the current activity *i* (delayed completion of activity *i*, blocked or unavailable resources for next activities $i + 1$, $1 \leq i \leq n - 1$);
- *Alarms* raised upon an interruption or failure in performing the current activity *i*; theses alarms create a progress report which signals the necessity of new resource allocation or activity redefinition to the Service Configuring and Set-up (SCSU) module, by generating a Service Reconfiguring Request (SRR).

Once the last activity *n* of the composite service terminated, a *service acknowledge* message (*service_ack*) is issued for the Service Follow-up activity component of the Operations Management stage, signalling the completion of the composite service delivery. This message will trigger the Service Performance Evaluation (SPE), as post-service delivery computational activity.

Fig. 9 describes the organization proposed for the **Service Follow-up** activity component with **Service Performance Evaluation**. There have been considered two types of services, with delivery just acknowledged by *service_ack*:

1. *Pure service* (S), no product (good) is sold: the completion of the service delivery is signalled by *service_ack* which, based on the service value data already measured during the Service Delivery and Monitoring activities and stored in the CSV database, triggers the calculation of:

   - <u>Value KPIs</u> for the (pure) service describing the *Asset Management* (AM), i.e. the provider's effectiveness in managing fixed and working capital assets to resolve clients' requirements:

     – RSWC: *return of service working capital*, for the recently delivered service;

– RSA: *return on assets* for the same service;
– SCCCT: service cash-to-cash cycle time.

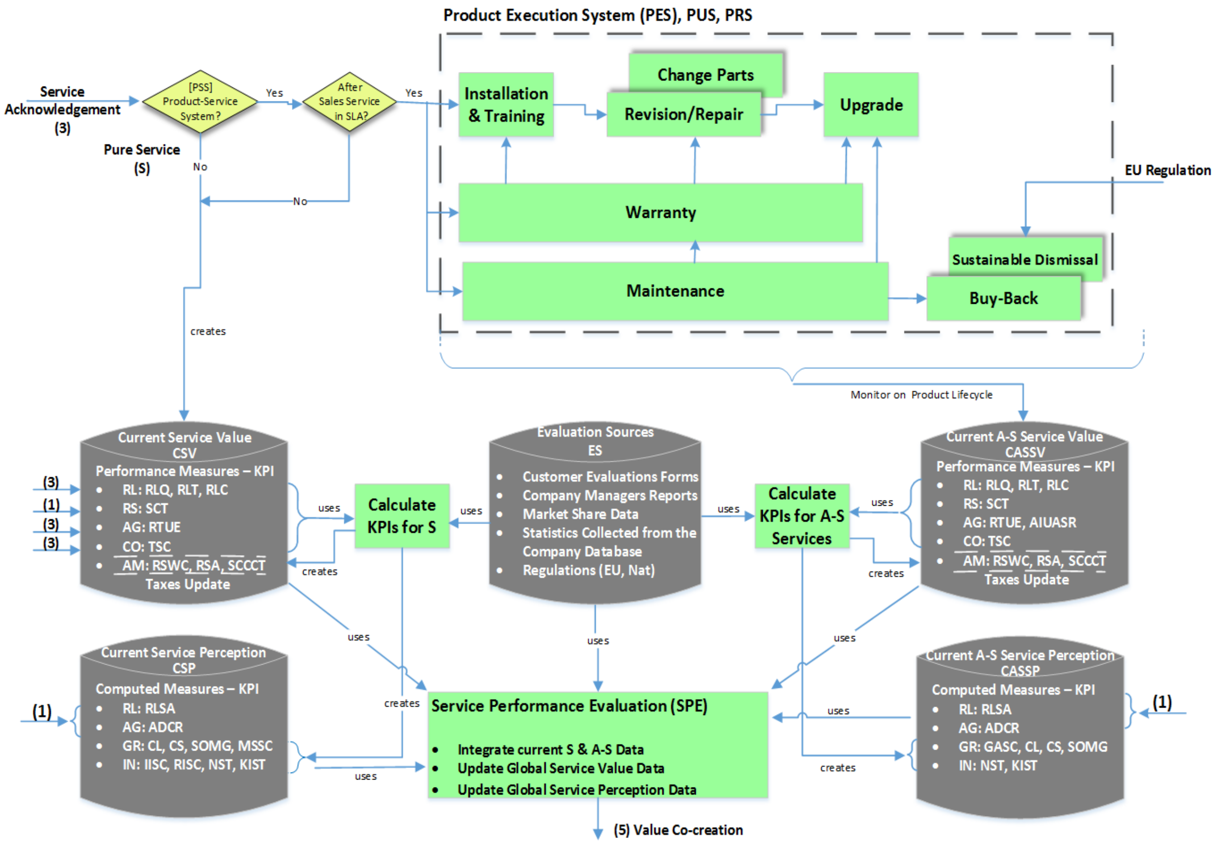


Fig. 9. Service Follow-Up and Performance Evaluation

- Perception KPIs for the (pure) just delivered service - these KPIs are added to the service perception data retrieved during the Service Contracting activity - describing:
  - ➢ the provider's *Growth* (GR) after the recently delivered service, i.e. the company's ability to grow along the time and generate a net income on a consistent and sustainable basis:
    - o CL: *customer's loyalty*, estimated in terms of client identification in the provider's customer database;
    - o CS: *customer's satisfaction*, retrieved from the evaluation sheets the clients fill in after service delivery;
    - o SOMG: *service operating margin growth*, estimated post service delivery by the provider's staff.
  - ➢ the provider's *Innovation effort* (IN) by considering the way in which the currently delivered service has contributed to the company's capacity to innovate and create new and knowledge-intensive services:

- IISC: number of *incremental innovations* (improvements) identifiable for the just delivered service;
- RISC: number of *radical innovations* registered for the just delivered service;
- NST: number of *new services* created and sold relative to the recently delivered composite service;
- KIS: number of *Knowledge Intensive* (KI) - *services* created and integrated in the recently sold and delivered composite service.

2. *After-sale service* (A-SS) or Product-Extension Service (PES) enhancing the utility that the ownership of the product delivers to the customer (e.g. repair, maintain and upgrade, take-back etc.) - see top right part of the representation in Fig. 9; after the product is sold to the client, the A-SS is monitored during the whole product lifecycle, and, based on the following data sets:

❖ *service value data*: RL (RLQ, RLT and RLC), RS (SCT) AG (RTUE and AIUASR - the adaptability of the Service System to the increase of unplanned A-SS requests), and CO (TSC), and

❖ *perception data*: RL (RLSLA),

already collected during the Service Contracting activity, the calculation of specific KPIs for A-SS is performed, and the following data bases are updated (see Fig. 4.11): the Current A-SS Value database (CASSV) respectively the Current A-SS Perception database (CASSP):

- <u>Value KPIs</u> for the A-SS describing, in addition to the *Asset Management* indicators AM (RSWC, RSA, and SCCCT), the *Growth* indicators:
  - GASC: *growth of A-SS contracts*, by adding the last one contracted;
  - SOMG: *service operating margin growth*, estimated post A-SS delivery by the provider's staff
- <u>Perception KPIs</u> for the A-SS describing, in addition to the service perception data RL (RLSLA) and AG (ADCR) retrieved during the Service Contracting activity, the *Growth* indicators GR (CL, CS) and the *Innovation effort* indicators IN (NST and KIST).

The value and perception data measured and collected during service delivery and the KPIs for current service value and perception calculated during the Service Follow-up activities are stored in the CSV and CSP databases for the current (pure) service, respectively in the CASSV and CASSP databases for the current after (product) sales service.

These data are then integrated with the historical data kept for that types of services in the provider's Global Service Value Database (GSVD) and Global Service Perception Database (GSPD), during the **Service Performance Evaluation** (SPE) activity; these two global databases are then checked against the customer's requirements for a new request of a service of that type during the process of value co-creation.

PSE is used:

- to analyze the company's (service provider) financial results in terms of: costs, revenues, operating profit, Return On Assets (ROA) and cash flow;
- to analyze the company's competitive performance in terms of: market share, customer satisfaction, customer loyalty and ranking among competitors (results);
- to analyze the company's innovativeness;
- to support the value co-creation process.

6 Extending products with services in Product-Service Systems (PSS)

As discussed in the previous chapter 5, the **Service Follow-up** activity is extended to services to be performed after a product is sold to the customer; such services, After-Sales service (A-SS) or Product-Extension service (PES) represent a category of Product Service System (PSS) and are characterized by the customer ownership of the physical good.

The concept of "*Product-Service System*" (PSS) was first defined by Goedkoop et al. (1999) in order to identify a "marketable set of products and services capable of jointly fulfilling a user's needs". A PSS uses a physical product as vehicle for delivering generic or specific services related to that product.

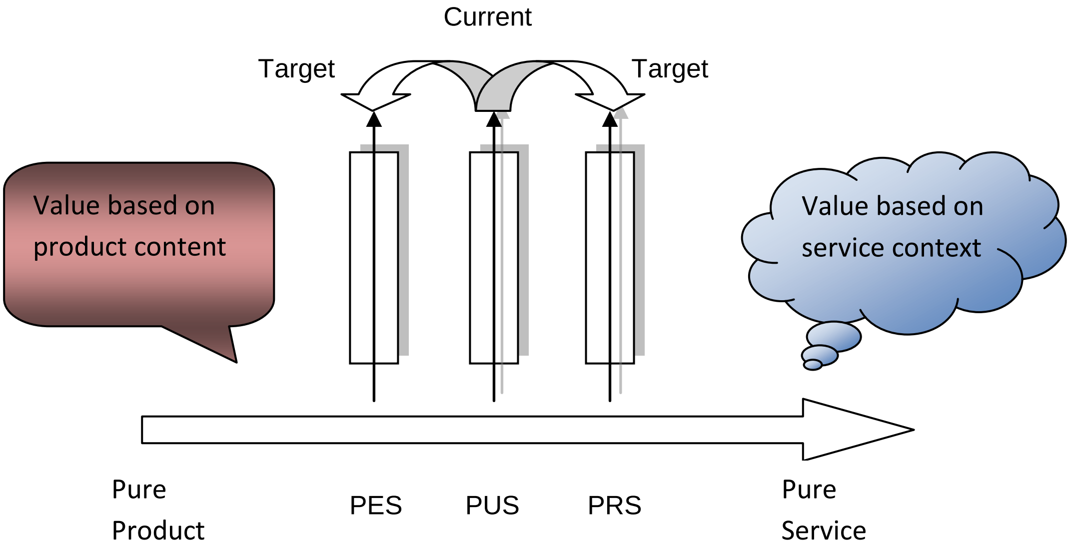


Fig. 10. The *continuum-type transition* from pure-product to pure-service business

The transition from pure-product to pure-service providers is a *continuum* and manufacturing firms move along this axis as they incorporate more product-related services (see Fig. 10).

For the Service System (SSyst) activity model, there have been considered for further management analysis and design three categories of PSSs, according to who owns the PSS and who uses it:

- <u>Product-Extension services</u> (PES), also called <u>After-Sales services</u>: this category is characterized by the customer ownership of the physical good.

- Product-Utility services (PUS): this category refers to two main areas of services which are connected with rentals and leasing.
- Product-Result services (PRS): this category is related to situations where a provider supplies a complete solution to an on-going need for a customer.

A key issue is to monitor and control all the processes and activities which are carried out to provide a product-service business: service measures need to be implemented and applied consistently by all the parties involved in the service network in order to enhance its overall effectiveness.

6.1 Activity Model and Follow-up of After-Sales Services

An After-Sales service (A-SS) or Product-Extension service (PES) is a category of Product Service System (PSS) characterized by the customer ownership of the physical good. Product-Extension services enhance the utility that the ownership of the product delivers to the customer (e.g. repair, maintain and upgrade, take-back etc.) - see Fig. 11 below.

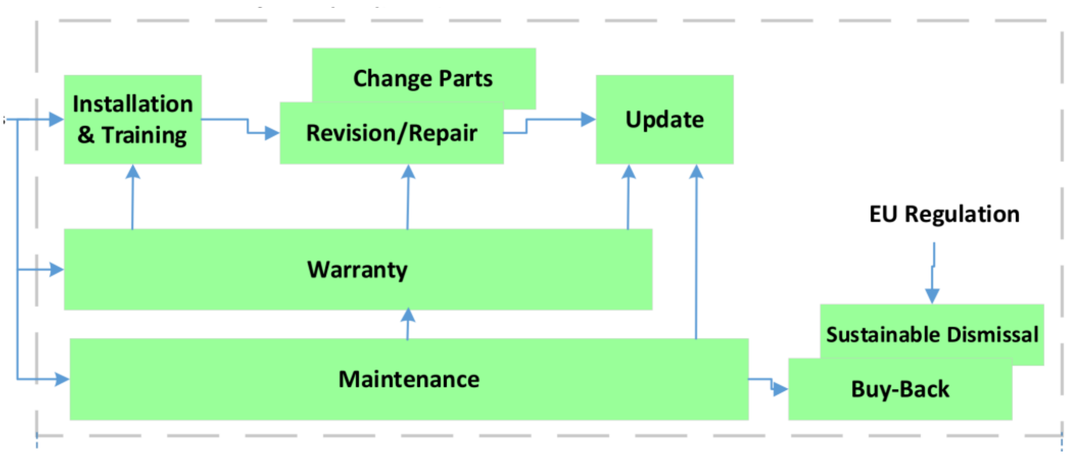


Fig. 11. A-SS activities proposed for the SSyst activity model

In particular, this class of product-based services refers to services which are usually provided and managed during the middle and end of life phases of a product life cycle and are created to support customers in the utilisation and disposal of goods; for this reason, they are also called After-Sales services.

Four categories of activities may be involved in A-SS

- *Services associated with selling the product*: they are required during the process of transferring the ownership of the product to the customer in order to make it work (they can be: installation, training, product documentation, financial or insurance services and extension or customization of the warranty);
- *Services associated with the use of the product*: they are required to facilitate and improve the procedures for an efficient use of the product by the user as well as to assess periodically any unforeseen issues that may arise (they can be: customer care, upgrades and product check-up);

- *Services associated with the recovery of product functions*: they include all activities, mainly of technical nature, for maintenance and repair of products and replacement of defective parts, in order to restore the functionality of the product;
- *Services associated with the disposal of the product*: they refer to absorbing EU regulations regarding the sustainable dismissal of the products at the end of their useful life span.

Table 2 below proposes KPIs for performance evaluation (value and perception) of After-Sale services; some of the service perception indicators are used to analyse the firm's innovativeness and capacity to create new and knowledge-intensive services.

Table 2. KPIs proposed for A-SS value and perception evaluation

A-S Service Performance Evaluation	**Performance category**			**KPIs**
	Type	Description	Estim.	
Service Value (SV)	Reliability (RL)	Performance of the SSyst. to answer right to customer needs	meas.	RLQ: quality of service
			meas.	RLT: service timeliness
			meas.	RLC: provide the right answers to client enquiries (consistency)
	Responsiveness (RS)	Speed at which client enquiries are resolved by the SSyst.	meas.	SCT: service cycle time
	Agility (AG)	SSyst. agility to respond to market changes to gain/maintain competitive advantage	meas.	RTUE: reaction time to unplanned events
			meas.	AIUASR: adaptability to the increase of unplanned A-SS requests
	Cost (CO)	Cost reported by the company to operate the SSyst. to resolve customer inquiries	meas.	TSC: total service costs
	Asset Management (AM)	Company's effectiveness in managing fixed and working capital assets to resolve client inquiries	comp.	RSWC: return on service working capital
			comp.	RSA: return on assets
			comp.	SCCCT: service cash-to cash cycle time
Service Perception (SP)	(RL)		meas.	RLSA: generate the right SLA-contractual agreement in place
	(AG)		meas.	ADCR: adaptability to customized requests
	Growth (GR)	Company's ability to grow along the time & generate a net income on a consistent and sustainable basis	comp.	CL: customer loyalty
			comp.	CS: customer satisfaction
			meas.	GASC: growth of A-SS contracts
			comp.	SOMG: service operating margin growth
			comp.	MSSC: market share per service category
	Innovation (IN)	Company's capacity to innovate and create new and KI services	comp.	NST: no. of new services created and sold from total services
			comp.	KIST: no. of KIS from total A-S services

6.2 Activity Model and Follow-up of Product-Utility Services

A Product-Utility service (PUS) is a category of Product Service System (PSS); this category refers to two main areas of services which are connected with *rentals* and *leasing*.

The provider is still the owner of the product but the customer uses directly the product and the related service (e.g. car leasing, car rental, property sharing, etc.), see Fig. 12.

Product Utility Service [PUS]

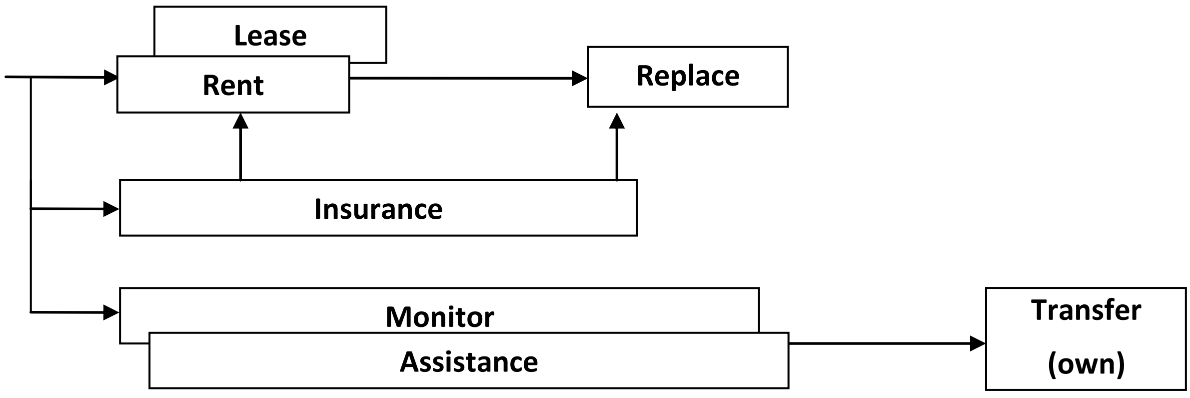


Fig. 4.14. PUS activities proposed for the SSyst activity model

As compared to the activities associated with the Product-Extension services (or A-SS), the activities related to PUS impose a minimum of *compulsory insurance* that can be optionally extended to cover all situations possibly ocurring during the utilisation of the product, monitor in more details whether the product is properly used, and provide complete technical assistance to the customer over the entire product's life cycle (Fig. 12). The same KPIs for the A-SS evaluation can be used for the PUS.

6.3 Activity Model and Follow-up of Product-Result Services

A Product-Result service (PRS) is a category of Product Service System (PSS) related to situations where a provider supplies a complete solution to an on-going need for a customer. The client does not own and use the product, but uses instead only the product's functionality and the results created (such as energy service contracting, voicemail, etc.), see Fig. 13.

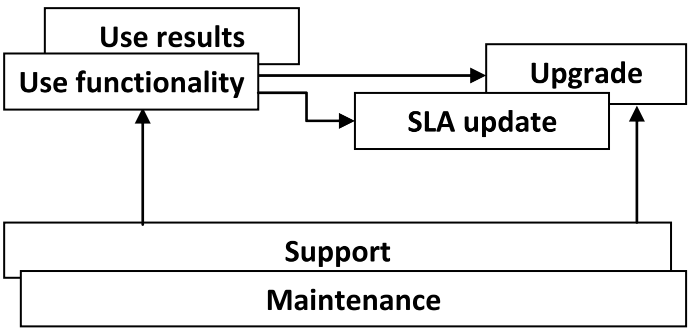


Fig. 4.15. PRS activities proposed for the SSyst activity model

A permanent activity, diversified by the customer's perception on the product's functionality, degree of satisfaction and fidelity is the upgrade of the technical conditions and performances in which the product's functionality can be used and the Service Level Agreement update (upon the provider's proposal, agreed with the customer).

The same KPIs for the A-SS and PUS evaluation can be used for the PRS.

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