Economic Modelling of Forest Service Providers in Hungary

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ABSTRACT

This study presents a financial modelling analysis of licenced forestry specialist services and forestry operation services based on skidding and forwarding. An enterprise needs to provide forestry specialist services on 1,500–2,500 ha and achieve 36,000–37,000 EUR turnover to finance the full-time employment of one person and to attain 10% profit on turnover. Forestry contractors that harvest wood by skidding with a farm tractor need to harvest 4,300–5,500 m^3 annually and generate 120,000–130,000 EUR income per year, while an output of 7,700–10,100 m^3 of harvested wood and 210,000–220,000 EUR of income is needed in forwarding.

TANULMÁNY INFÓ

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KIVONAT

Magyarországi erdészeti szolgáltató vállalkozások gazdasági modellezése. Ez a tanulmány a jogosult erdészeti szakszemélyzeti és az erdészeti kivitelezési szolgáltatások pénzügyi modellezésének elemzését mutatja be. Megállapítást nyert, hogy egy vállalkozásnak 1500-2500 hektáron kell jogosult erdészeti szakszemélyzeti szolgáltatást nyújtania, és 36 000-37000 EUR árbevételt kell elérnie ahhoz, hogy finanszírozni tudja egy fő teljes munkaidős foglalkoztatását, és 10%-os árbevétel arányos nyereséget érjen el. A mezőgazdasági traktorral végzett közelítésre épülő fakitermelési szolgáltatások esetén évente 4300-5500 m^3 fát kell kitermelniük, és évi 120-130 ezer EUR bevételt kell termelniük, míg a forwarderes fakitermelés esetében 7 700-10 100 m^3 kitermelt fára és 210-220 ezer EUR bevételre van szükség.

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1 INTRODUCTION

The beginnings of today's private forestry in Hungary can be traced back to the political and economic changes that started in 1989 (Gerely – Schiberna, 2004). Like other countries in East Europe, private forests in Hungary were created by privatising former agricultural cooperative forests and partially privatising state-owned forests (Weiss et al., 2019). Significant afforestation on privately owned farmlands has also occurred since this period.

The two major prerequisites of lawful forest management are a) a Manager of Forest (MOF) with proper land use rights registered with the Forest Authority and b) a Licenced Forest Specialist (LFS) employed or contracted by the MOF. MOF can be an organisation or an individual bearing the legal responsibility for forest management. Forest policy measures (regulations and subsidies) have prioritised collective management due to the lack of forestry tradition, knowledge and capital among the new owners.

The unique characteristic of land privatisation in Hungary is that a significant proportion of private forests (65%) are in common ownership, where the owners must agree on how their forests will be managed (Mertl – Schiberna, 2017).

New owners were unmotivated to form larger management units, and many owned small properties. Thus, they were uninterested in participating in the lengthy administrative process of appointing their own MOF and LFS.

Private forest management in Hungary faced significant problems by the early 2000s. In 2000, only 413,000 ha of the 757,000 ha of privately owned forest had a forest manager registered by the forestry authority. Legal forest management is impossible without a registered forest manager.

Another indicator of the state of the private forestry sector is the area of delayed reforestation. According to regulations, reforestation must start within two years of the final cut and must be finished by a species-specific deadline. The area of delayed reforestation was 9,096 ha in 2000, of which 5,831 ha missed the start deadline, while 3,265 ha missed the end deadline. The total reforestation started in the same year was 8,795 ha.

A subsidy scheme launched in 2000 to facilitate private forestry sector development aimed to establish a network of forestry service providers. Financial support was available for enterprises that were MOFs on 200 to 4,000 ha of forest and provided LFS services to other MOFs on at least 200 ha and forestry operation services on at least 50 ha. These service hubs were called 'forestry integrators', and they were expected to extend their services to trading timber and propagation materials and to become major facilitators in rural development programs by writing subsidy applications for their partners (Schiberna et al., 2011).

Hungary accessed rural development funds when it joined the European Union (EU) in 2004. At the time, the EU's Rural Development Programme included support for advisory services, but the integrator model did not fit into this framework, so the national budget needed to maintain this service network, which was eventually discontinued in 2010.

Subsequently, the improvement in the above indicators for the private forestry sector stopped and began to decline after a few years of stagnation. In 2010, the size of delayed reforestation was 4,411 ha, while the area without a forest manager was 175,279 ha. This trend was reinforced by a legislation change that led to the cancellation of registered forest managers over a large area. Since then, private forest land without forest managers (304,589 ha in 2021) and the area of delayed reforestation (11,082 ha in 2021) have fallen back to levels seen in the early 2000s. Meanwhile, the timber markets, including firewood, which accounts for 59% of the Hungarian timber harvest, grew steadily between 2004 and 2020.

Market conditions, regulations, rural development schemes, and other subsidies strongly influence private forestry development in Hungary. Consequently, forest owners and MOFs

need credible and up-to-date information to deal with the frequent variations and changes in the above factors.

Since the privatisation began, the overall change in forest area has resulted in 55.9% of the total forest area in public ownership, 1.0% in community ownership and 43.2% in private ownership (Ministry of Agriculture, 2023a).

2 PROBLEM IDENTIFICATION

According to the Forest Act (2009. XXXVII), the forest owner— or owners in the case of joint ownership—decides on forest property use, including MOF and the LFS designation. The MOF can be an owner or a third party. The Forestry Authority registers MOF in all cases. Depending on the land use contract, the owner(s) may withhold some of the use rights, such as timber removal decisions, forest reforestation type or other business decisions. However, all legal liability rests with the MOF.

The MOF must cooperate with an LFS to meet professional standards in forest management activities. Individuals or enterprises employing a forester can provide LFS services. The Forestry Authority issues a licence to foresters who have obtained the required work experience and passed the compulsory forest administration exam. LFS is responsible for the validity of forestry documentation and forestry field activity supervision.

Forestry operation contractors (FOC) perform most of the work in private forests in Hungary. Most contractors are small and have low-value machinery. Some work in other sectors outside the logging season.

Based on the above, at least four functions must be in place for forest management to start—the owner(s), the MOF, the LFS, and the contractor. A single person may perform these functions; however, in practice, they are likely performed by separate persons or companies. A capable actor is needed to coordinate the process. *Table 1* summarises why the LFS has the best potential for organisational capacity in most cases.

Table 1. Characteristics of the forest owner, the forestry manager (MOF), the licensed forest specialist (LFS) and the contractor (FOC)

Stakeholder	Legal knowledge	Forestry knowledge	Resources	Motivation
Owner(s)	No formal training, frequent changes in legislation are difficult to follow	No forestry tradition and education	Restricted	Low, especially small property size, middle-aged or young forest, or in the absence of urgent forestry intervention
MOF				Low, income from forests as an independent source of livelihood is rare
LFS	Continuous experience	Must have formal forestry education and work experience	Depends on size	High, they rely at least partly on incomes from LFS services
FOC	No formal training, mostly rely on LFS guidance	Practical skills, limited administrative skills	Lack of financial sources due to low profitability	High, FOC services are their main income source

A challenging step in organising forest management is knowing the legal options and frequent legislation changes in land use issues, administrative procedures, and forestry law. Understanding forest management processes thoroughly and realistically assessing the economic potential of forest management is crucial. Organising forest management requires

considerable time to obtain data, maintain formal correspondence with stakeholders and complete administration tasks. Such work is time-consuming, and costs must be covered in advance.

In light of the above, forestry LFS plays a key role in developing private forestry. This article examines the minimum conditions for LFS service provider operation, including costs and minimum revenues, and calculates the minimum service area. Similarly, two types of forest operation contractors are also analysed to reveal their cost structures and minimum service volumes (area and volume of timber harvested).

3 DATA AND METHODS

This study developed models to gauge the conditions under which an LFS service enterprise can operate, estimate the costs of fulfilling these conditions, calculate the revenues needed to cover the costs and the operational area that can provide these revenues. The modelling assumes that such an enterprise operates under strict cost restrictions and aims to exceed the breakeven point.

The same modelling procedure is used to examine the financial conditions of logging services in two scenarios: one assuming a lower technical standard and one assuming a higher technical standard.

LFS and FOC services were modelled based on personal interviews with four LFS and four FOC enterprises. The interviewees were selected from various parts of the country, the operating area of which—especially in the case of larger logging enterprises—covers multiple geographical regions with various natural conditions. Although forest types, topography, soil conditions, logging techniques and other factors can significantly impact work efficiency and financial conditions, the modelling was designed to represent the average situation these enterprises face.

The contractor fees for forestry activities were obtained from the 2023 annual forestry fee survey (Ministry of Agriculture, 2023b) and adjusted according to the fees reported by the interviewees. Detailed cost structures were developed to calculate logging costs. Enterprise operating costs, including equipment rental fees, maintenance costs, salaries and overhead costs, were compiled according to the interviews.

The model calculation includes variable costs, fixed costs, target profit margin and unit service prices. The volume of services required for a profitable long-term operation—the ultimate aim of the analysis—is calculated using formula (1), constructed by the authors.

$$Q = \frac{FC}{(1-r)P-VC} \tag{1}$$

Where:

Q:	service volume (ha; m^3)
FC:	fixed costs (EUR)
r:	profit margin on turnover (%)
P:	unit price of service (EUR/ha; EUR/m^3)
VC:	variable costs (EUR/ha; EUR/m^3)

Financial values are presented at a 400 HUF/1 EUR currency exchange rate. Original calculations were conducted in HUF; therefore, minor rounding errors may occur, but none affect the conclusions.

4 RESULTS

4.1 Model of a LFS service provider

Enterprises solely providing LFS services must keep costs as low as possible, especially at the initial development stage. Business, family infrastructure, and overhead costs (telecommunications, car) that may be combined or mixed in the short term are tolerable for such enterprises.

LFS service is the only activity of a model enterprise during its first few years of operation. Such service includes forestry operations supervision, fieldwork (designating logging area and marking trees to be felled) and administration. In addition, the LFS advises the MOF and acts on behalf of the MOF in official processes such as forest management planning and forest authority field inspections. LFS also monitors the forest area and manages and documents calamities, e.g. by submitting forest protection reports.

LFS service does not include harvested wood stock inventorying, timber sales, invoicing, etc. Writing subsidy scheme applications is not part of the basic LFS service either.

Table 2. Financial model for LFS service enterprise

Type of cost	Justification	Expenses (EUR)
Equipment rent	1 Off-road vehicle	6,000
Maintenance	Annual maintenance costs of an off-road vehicle	600
Personnel	12 monthly salary + benefits	21,425
	Working clothes	188
Overheads	Accounting and other administration	600
	Insurance	250
	Office equipment + communication + utility	750
	Marketing	750
Total fixed costs		**30,562 EUR/yr**
Operating costs	Gasoline	1.3
Total variable costs		**1.3 EUR/ha**
Profit margin	10% profit on turnover	10%
Service unit price		15-25 EUR/ha
Minimum operating area		**1,500–2,500 ha**
Revenue of the minimum service volume		**36,000–37,000 EUR**

4.1.1 Equipment and maintenance

Table 2 shows LFS service enterprise modelling. In the present model, the enterprise rents a durable off-road vehicle for 6,000 EUR to cover a fragmented and scattered service area. Equipment, such as phones, laptops, printers, software, GPS devices, etc., are partly included in overhead costs, but the model also assumes that family equipment can be used.

The off-road vehicle requires annual maintenance, including tyres, oil changes, other maintenance, and safety inspections, which total about 600 EUR. These costs are independent of vehicle usage. Hence, they are fixed costs. Gasoline is included in the variable costs.

4.1.2 Personnel

According to the Hungarian Central Statistical Office (KSH), the average gross monthly salary for full-time employees in Hungary in January–February 2024 was 1,513 EUR, subject to an 18% social security fee. The model assumes that the LFS is the only employee in this enterprise

and that the LFS earns the average salary, bringing the total annual salary cost for this enterprise to 21,425 EUR.

4.1.3 Overheads

The present model does not include separate office rental costs because it assumes the free use of own property. An external company provides the accounting service for 50 EUR/month, or 600 EUR annually. The model estimates the necessary insurance to be 250 EUR per year and office equipment, communication and overhead costs to be 750 EUR per year. The marketing budget for advertising and participation in professional gatherings is 750 EUR per year.

4.1.4 Operation

Most business expenses in an LFS service enterprise are fixed; the volume of operation and the service area have little influence on costs. The only identified variable cost is gasoline for the off-road vehicle, which strongly correlates with the service area size and location(s). The present model calculates an average gasoline cost of 1.3 EUR/ha/yr.

4.1.5 Calculation of minimum service volume

The fixed cost is 30,562 EUR per year, while variable costs are 1.3 EUR/ha. The unit price of LFS service ranges between 15 and 25 EUR/ha/yr. The minimum service volume calculated with formula (1) and rounded up to the nearest 100 is 1,500 to 2,500 ha. This service area generates 36,000–37,000 EUR (rounded up to the nearest 1000) of turnover per year, which covers business expenses and allows for a 10% profit.

4.2 Logging services – low technical standards

A typical form of service logging among logging contractors is an agricultural tractor under 75kW equipped with a winch and operated by a small crew. Black locust (*Robinia pseudoacacia)* and poplar *(Populus sp.)* plantations are harvested by clearcutting followed by an artificial regeneration by planting seedlings or root-coppicing. Since there are no remnant trees or seedlings that could be damaged during harvest operations, logs are transported to the depot by skidding.

The process in such logging systems starts with motor-manual felling and delimbing. Skidding is done by a farm tractor with a winch, which takes the trunk to the depo area, where it is cut into smaller wood products. Depending on the stand properties, the logging team consists of one feller, one tractor driver, one cutter at the depot and two hand-stackers.

This equipment is unsuitable for felling stands of large trees (over 1 m^3/tree) and in areas where skidding would damage forest regeneration. This logging system is more suitable for producing small wood products (e.g. firewood), primarily because handling and stocking larger logs in the depo area would require a separate machine.

The financial modelling of the above logging service assumes a medium stand of black locust tree species with a yield of 200–250 net m^3/ha and a slope below 10 degrees (*Table 3*).

4.2.1 Equipment and accessories

The most important machine of this model enterprise is the farm tractor equipped with a roll-over frame and a forestry winch, which is rented in this case. The price of a used farm tractor is 7,500 EUR, and the forestry winch is 1,500 EUR. Both have a remaining service life of three years. The annual rental fee for this equipment is 3,000 EUR.

The team needs an off-road vehicle to commute to and from the forest. The annual rental fee of this vehicle is estimated at 1,250 EUR.

The model business is based on two chainsaws, assumed to be in operation for three years. Their rental is about 750 EUR per year.

Some smaller accessories are also needed: signs to mark the working zone for forest visitors, bins to collect waste, fire extinguishers and hand tools. The annual cost of these is estimated at 750 EUR.

The cost of workwear and safety equipment for fellers working with chainsaws is 750 EUR/worker, with a three-year expiry date. This cost includes a safety helmet, gloves, ear protection, protective trousers, jacket, safety boots, and underwear. Trousers and jackets are cheaper for hand-stackers and tractor drivers and cost roughly 250 EUR/worker with a three-year replacement period. In total, the annual cost of the team's workwear and personal safety equipment is 750 EUR.

Table 3. Financial model for logging services – low technical standards

Type of cost	Justification	Expenses (EUR)
Equipment rent	1 Farm tractor with roll-over frame and winch	3,000
	1 Off-road vehicle for 5 workers	1,250
	2 Chainsaws	750
Maintenance	Tractor maintenance	500
	Maintenance and safety inspection of chainsaws	750
	Maintenance of off-road vehicle	500
Accessories	Safety signs, rubbish bin, fire extinguisher, tools	500
	Safety equipment for the team	750
Personnel	Salary + benefits for the team (12 months)	74,750
Overheads	Accounting and other administration	600
	Insurance	500
	Communication + utility + other	750
Total fixed costs		**84,600 EUR/year**
Operating costs	Chainsaw gas and lubricant	1.12
	Chainsaw wearing parts (chain, bar)	1.88
	Tractor fuel and lubricants	1.20
	Transport of equipment	0.30
Commuting	Fuel	0.38
Total variable costs		**4.88 EUR/m^3**
Profit margin	10% profit on turnover	10%
Service unit price		22.5–27.5 EUR/m^3
Minimum service volume		**4,300–5,500 m^3/year**
Minimum operating area		17–22 ha
Required daily output*		21–28 m^3/day
Required daily output per 1 person*		4.4–5.6 m^3/worker/day
Minimum service volume revenue		**120,000–130,000 EUR**

*Refers to productive days (productive working days/total working days = 85%)

4.2.2 Personnel

The logging industry usually does not employ full-time, permanent workers and usually pays hourly wages; however, this model assumes full-time status for 12 months a year with 20 days of paid leave because finding and keeping skilled workers has become an increasing challenge, one we believe can be alleviated by offering predictable and stable incomes.

The average gross salary of the logging workers in the above-described employment scenario is 1,050 EUR per month, subject to an 18.5% social security fee. This represents a total annual salary of 74,750 EUR for a five-person team.

4.2.3 Overheads

The present model assumes the outsourcing of the most important administrative tasks of the enterprise, such as bookkeeping, tax declaration and statistical reporting and sets these costs at 600 EUR a year. Accident insurance for the machinery and the employees and liability insurance for the enterprise amounts to 500 EUR per year.

Although the enterprise does not have a separate office, it still requires office supplies, which, together with postal charges, communication fees, and other administrative overheads, equals 750 EUR per year.

4.2.4 Operation

The most significant items among variable costs of logging services are fuel and lubricants for the tractor and the chainsaws and the saw chain and saw bar replacement. These items depend heavily on whether hardwood or softwood is harvested. Here, we assume hardwood production.

When logging in a new area commences, the farm tractor is transported or driven to the new location, depending on the distance. The logging team needs to commute to and from the forest, the distance of which can vary. *Table 4* presents these cost items.

Table 4. Major variable costs of logging services – low technical standards

Cost item	Rate of use	Unit cost	Logging costs
Saw chain	1 chain/50 m^3	62.5 EUR/chain	1.25 EUR/m^3
Chainsaw bar	1 bar /100 m^3	62.5 EUR/bar	0.625 EUR/m^3
Chainsaw lubricant	0.2 l/ m^3	2.5 EUR/l	0.5 EUR/m^3
Chainsaw fuel	0.5 l/m^3	1.25 EUR/l	0.625 EUR/m^3
Tractor fuel	1.0 l/ m^3	1.25 EUR/l	1.25 EUR/m^3
Tractor relocation	1 time per 1000 m^3	250 EUR/1000 m^3	0.25 EUR/m^3
Workers daily commuting	10 l/day -> 0.3 l/m^3	1.25 EUR/l	0.375 EUR/ m^3

4.2.5 Calculation of minimum service volume

The price of logging services varies over a broad spectrum. According to forestry market statistics, the service fee for black locust final harvest on less than 10-degree slopes in 2023 was 24.7 EUR/m^3 (KSH, 2024). The model calculates 22.5 and 27.5 EUR/m^3. The minimum service volume, calculated according to formula (1) and rounded up to the nearest 100, was 4,300–5,500 m^3/year, which (based on an average net timber yield of 250 m^3/ha), implies 17–22 ha of logging work a year.

On average, there are 250 working days and 20 paid holidays a year. Furthermore, about 15% of working days are unsuitable for logging due to weather factors. Thus, minimum service volume can only be attained if the team achieves an average output of 21–28 m^3/day on actual working days, which means an output of 4.4–5.6 m^3/person/day.

The turnover for the minimum level of service is 120,000–130,000 EUR, rounded up to the nearest 10,000.

4.3 Logging services - high technical standards

Another conventional logging method is the motor-manual felling combined with forwarding, which causes less soil disturbance and less forest regeneration damage. Forwarders can carry 10–15 m^3 of timber to distances up to 1 km. In comparison, the efficient skidding distance for a farm tractor is 100–200 m.

In this logging method, the tree is felled, delimbed and then cut into half by one feller. The forwarder takes the pre-cut wood to the depot area, where three workers cut them to size. The

forwarder also loads the wood into stacks or piles, according to product type. This logging method can be operated with a crew of five.

As before, the modelling assumes a medium-yielding black locust (*Robinia pseudoacacia)* stand with a net yield of 200–250 m^3/ha and a slope of less than 10 degrees. (*Table 5)*

The two logging methods are similar in workflows and costs; therefore, the description below covers only the differences.

Table 5. Financial model for logging services - high technical standards

Type of cost	Justification	Expenses (EUR)
Equipment rent	1 Forwarder	37,500
	1 Off-road vehicle for 5 workers	1,250
	4 Chainsaws	1,500
Maintenance	Forwarder maintenance	7,500
	Maintenance and safety inspect. of chainsaws	1,500
	Maintenance of off-road vehicle	500
Accessories	Safety signs, rubbish bin, fire exting., tools	500
	Safety equipment for the team	1,075
Personnel	Salary + benefits for the team (12 months)	85,963
Overheads	Accounting and other administration	600
	Insurance	2,500
	Communication + utility + other	750
Total fixed costs		**140,138 EUR/yr**
Operation	Chainsaw gas and lubricant	1.12
	Chainsaw wearing parts (chain, bar)	1.88
	Forwarder fuel and lubricant	2.5
	Transport of equipment	0.38
Commuting	Fuel	0.37
Total variable costs		**6.25 EUR/m^3**
Profit margin	10% profit on turnover	10%
Service unit price		22.5-27.5 EUR/m^3
Minimum service volume		7,700–10,100 m^3 /year
Minimum operating area		31–40 ha
Required daily output*		39-52 m^3/day
Required daily output per person*		7.8–10.3 m^3/worker/day
Minimum service volume revenue		**210-230 000 EUR**

*Refers to productive days (productive working days/total working days = 85%)

4.3.1 Equipment and accessories

We assume the logging enterprise rents a new forwarder for 37,500 EUR annually. In financial terms, this is the same as buying a new forwarder for 375,000 EUR and selling it for 187,500 EUR in 5 years.

According to the working method, the model requires four chainsaws, which can be rented for 1,500 EUR per year.

Since the team composition is different from the previous logging method, safety equipment and workwear costs are re-calculated for four chainsaw workers and a forwarder driver. Considering a three-year replacement period, the total cost is 1,075 EUR.

4.3.2 Personnel

Logging with a forwarder requires more chainsaws and, in the case of the forwarder operator, higher qualifications. Although the crew size is the same as the farm tractor logging, the labour cost is 15% higher. In total, this model enterprise spends 85,963 EUR a year on the crew's salary.

4.3.3 Overheads

The only difference in the operating costs of the enterprise compared to the previous model is the higher insurance cost (2,500 EUR) due to the higher asset value.

4.3.4 Operation

In the present logging method, the forwarder not only carries the wood to the depot but also needs to stack and pile the wood products. In addition, forwarders typically operate at greater distances. The fuel consumption per harvested volume is more than for skidding with the farm tractor, 1.3 l/m^3.

Forwarders are usually transported to longer distances and with larger transport vehicles; therefore, the relocation cost is higher, 0.38 EUR/m^3.

4.3.5 Calculation of minimum service volume

The minimum service volume, calculated according to formula (1) and rounded up to the nearest 100, is 7,700–10,100 m^3/year, which, based on an average net timber yield of 250 m^3/ha, represents 31–40 ha of logging work annually.

Based on the above calculation, the crew is expected to achieve an average output of 39–52 m^3/day on actual workdays, which translates into an output per person of 7.8–10.3 m^3/day.

The turnover for the minimum level of service is 210,000–230,000 EUR, rounded up to the nearest 10,000.

5 DISCUSSIONS AND CONCLUSIONS

5.1 Intellectual services

There is a clear distinction between two forms of forestry services in the literature: forestry consultancy and contractor services. In many countries, forestry advisory services are a forestry policy instrument designed to support private forest management, while in other countries, they are provided by private organisations on a market basis or with budget support (Lawrence et al., 2020). A comparable situation exists in the Balkan countries, but a separate Forest Extension Service was established in Croatia to supply services such as professional training and seminars (Glück et al., 2011). Forest contractor service providers, however, are private companies that typically operate under free market conditions. Although the internal conditions of each European country—natural conditions, forest characteristics, ownership and management, economic and labour market conditions, etc.—differ, these enterprises have very similar characteristics and face similar challenges (Rummukainen et al., 2006).

Forestry-related intellectual services can be classified into many distinct categories depending on their purpose, the type of activity, and the responsibilities attached. *Table* shows one way of categorising these services; some require additional qualifications.

Table 6. Categories of forestry services and their characteristics

Categories of intellectual services	Purpose of the service	Service output
Expertise	Expert examination of individual cases	Expert opinion, typically subject to eligibility e.g. forensic experts
Advice	General advice, exploring opportunities, e.g. market and funding opportunities.	Information materials
Engineering	Long-term plans or technical plans beyond the scope of day-to-day operations	Afforestation plan Forest management plan Road construction plan
Supervision	Ensuring forestry operations' compliance with regulations	Technical administration Field preparation Field inspection
Site management	Putting forestry skills into practice	Field management of operations

Expertise, i.e. expert opinion, is a service purely based on technical knowledge. The expert should not consider stakeholder interests, regardless of how the service is financed. Such expertise is typically used to support negotiations in disputed cases or official processes, e.g. forensic expertise. Such services are usually controlled by a third party and entail licencing or accreditation to ensure high standards.

Advisory services are general advice, including face-to-face consultation or even formal training, either on an ad hoc basis or through a long-term contact. Consultant seeks to provide beneficial advice to its partner, which usually includes identifying forest-related opportunities, helping to formulate forest management objectives, etc.

Forest engineering covers tasks that require forest engineer qualifications at a minimum of a BSc level. Typical examples include elaborating a forest management plan, an afforestation plan or a road construction plan.

Depending on national legislation, foresters can be responsible for ensuring that forestry operations comply with technical standards, including those set by legal regulations. In such cases, service providers act on behalf of the forest manager and are responsible for the technical administration and field inspection of the forestry operations. Field preparation tasks of an LFS described above also fall into this category.

The major difference between site management and supervision is that site management includes business decisions, and the service provider is responsible for the successful and efficient completion of forestry operations. A site manager controls and manages the contractor, decides what to produce, administers timber sales and other business processes, etc.

Forestry intellectual services can be classified by their content, the type of service providers and their motivations (*Figure 1)*. One source of intellectual services may be the state, which may provide support services either through a specialised advisory body or through its authorities or agencies. The primary purpose is to provide general information, facilitate legal compliance and promote subsidies and other forest policy measures. The impact of public intellectual services, if not accompanied by a financial incentive, is often only indirect or has an effect in the long term (Andrejczyk et al., 2016, Butler et al., 2014).

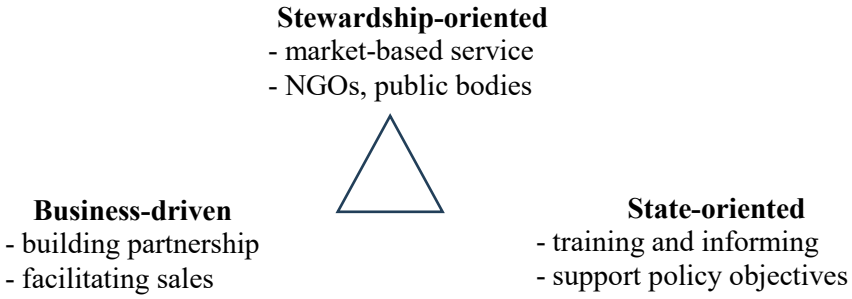

Figure 1. Characteristics of intellectual services providers by provider status

The various information campaigns and social marketing tools that encourage knowledge transfer or behaviour, regardless of how much they are targeted to forest managers (Butler et al., 2007), cannot be considered intellectual services.

The counterpoint to public intellectual services is the free or low-cost services offered by wood industry businesses willing to secure their access to raw materials. This type of service can only be viable in the long term if the interests of the service provider are also considered. Timber traders buying standing wood and managing logging are in this category (Curtis et al., 2023).

The purest form of intellectual services is when the MOF cooperates with the service provider on a market basis, and the interest of the MOF is the primary consideration. Associations, chambers and other cooperations of the MOFs can offer more affordable services. Training courses and workshops that combine knowledge transfer with planning and other practical programmes can also be included here (Zobrist et al., 2016).

Our modelling in the present study was based on a market-driven service situation aiming at long-term contractual cooperation between the MOF and the LFS. The calculations show that to run an LFS enterprise, assuming full employment of one professional, 1500–2500 ha of operational area would be needed, which would require a turnover of 36,000–37,000 EUR at 2023 prices.

In practice, LFS service enterprises provide further services and more specialised forest engineering services, such as afforestation planning, site surveying, administration of forest conversion, elaboration of management plan for continuous cover forestry, mapping, building fences against wild game, etc.

LFS service enterprises can help MOFs apply for subsidies or development grants. They are more informed about the opportunities in the first place, but they are also more capable of preparing the application documents with detailed technical information, and they have more confidence to take responsibility for meeting strict requirements.

5.2 Contractor services

The defining characteristics of forestry operation contractor services are that they are essentially performed by small enterprises operating in two different market segments. In the market of state-owned forestry companies, the bargaining power of forestry service providers is very weak. Prices are set by the customer, or at least competition among service providers can be generated. Accordingly, contractors are forced to reduce costs, which affects labour costs and the purchase, maintenance and operation of work equipment.

Consequently, such companies work with machines with low ergonomic and safety standards. Another consequence is that they cannot afford skilled labour, which, combined with poor working conditions, leads to ongoing labour problems. Due to the combined effect of the above factors, these enterprises are inefficient and, often, unprofitable. *(Figure 2)*

The advantage of this market is that state companies place large orders on the market, so the amount of work is more reliable and predictable. Although the independent development of service providers is not assured, the client can help the service provider by renting out up-to-date equipment and by developing long-term business relationships.

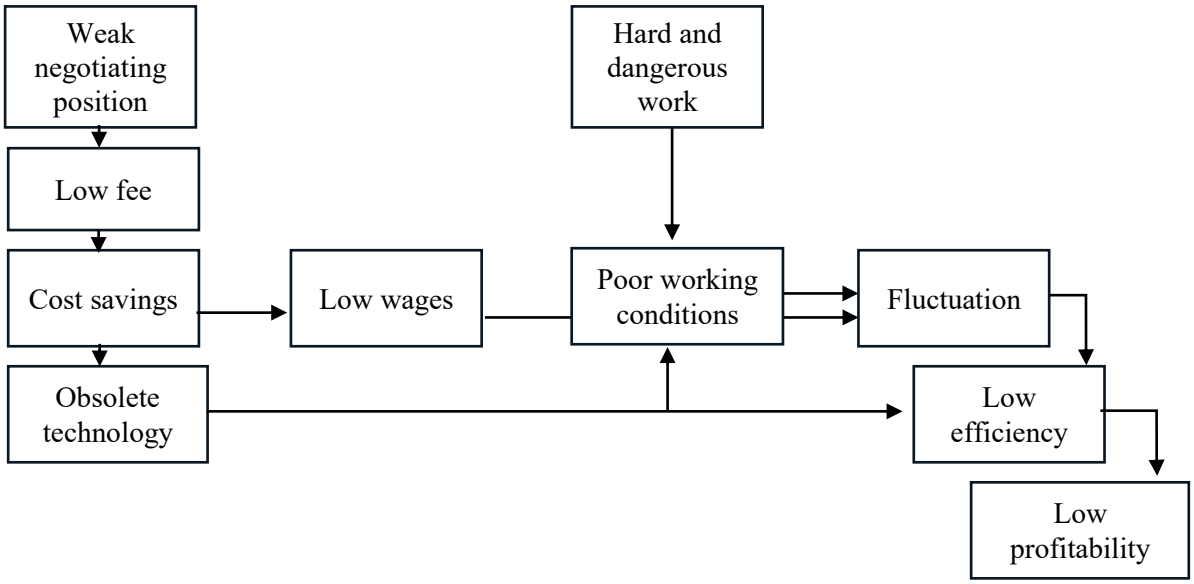

Figure 2. Consequences of low bargaining power of forestry contractors

In contrast, contractors in the private sector have stronger bargaining power, as some clients can only offer small jobs for which there is not much competition. If private forest owners and managers had the appropriate machinery and skills, they could perform the forestry work themselves, but they seldom do. This situation allows forestry contractors to negotiate a fee in line with operating costs. In such a market, the incentive to comply with contractual agreements is low due to casual business relationships, and legal enforcement is often unviable.

In the private forestry market, there may also be a reverse asymmetry between the service provider and the customer, where the service provider has more knowledge of the timber market than the client and, therefore, buys and trades timber in addition to harvesting *(Table 7)*.

Table 7. Characteristics of forestry contractors in different market segments

	Public sector	Private sector
Negotiating position	Customer dominates	Balanced between customer and service provider
Price	Low	Market-driven
Type of cooperation	Long-term, large orders, contractor rents machinery from client	Occasional and/or small orders compared to capacity
Trade opportunities	Not typical, at most for firewood in small quantities	Selling standing wood to contractor is common

In our analyses, we based the modelling of forestry service enterprises on the operations of real enterprises but used a significantly different logic to account for personnel costs than what was observed. Workers are employed primarily on a day-to-day basis in the forestry service

sector, which allows for flexibility when adjusting labour to the volume and nature of the work. However, given the increasing difficulty in retaining skilled and reliable workers, it was considered appropriate to assume full-time employment.

Two variants of logging services were studied, both widely used and could be a good starting point for an intellectual services company looking to broaden its services range. In the first option, the focus was on cost savings, and a low-tech second-hand farm tractor was chosen as the main machine. In the second version, we started with a simpler logging service but assumed the purchase of a more advanced and newer forwarder.

The main difference between the two logging service solutions is that the farm tractor option only allows the production of small products that can be moved manually. For this reason, the logging crew requires loaders in addition to sawyers. Another notable difference is that the carrying capacity of a forwarder is significantly higher than that of a farm tractor, about two to three times, so at least twice as many sawyers are needed to service it.

The calculations show that fixed and variable costs are lower for logging with a farm tractor. An annual output of 4,300–5,500 m^3 is required to achieve the targeted 10% return on turnover ratio, which assumes an output of 4.4–5.6 m3/person/day.

The fixed cost of forwarder harvesting is 67% higher, and the variable cost is 28% higher than for harvesting with a farm tractor. The volume required to achieve the targeted 10% return on a turnover ratio of 7,700–10,100 m^3/year is significantly higher (76%–81%), translating into a performance of 7.8–10.3 m^3/person/day. These productivity values are significantly lower than those observed in practice, suggesting that there are larger margins to achieve profitability in forwarder logging and that higher profits can be achieved compared to the target. However, a major disadvantage of forwarder logging is the high value of machinery, which requires higher capital or a stronger credit rating than for a much lower-value farm tractor.

According to our model, forest service providers offering forestry advice are expected to generate 36,000–37,500 EUR per year to cover their income and other expenses. Those providing logging services on lower and higher technical standards should generate 120,000 – 130,000 EUR per year or 210,000–220,000 EUR per year, respectively.

The forestry services market in Hungary is conservative (slow adaptation, lack of innovation) and based on the provision of services in the field of logging and forest consultancy. In the current macroeconomic circumstances, this causes problems in the forestry sector, associated with low prices for the services provided and a lack of workers in this market.

Based on the study results, we can conclude that forest service providers depend heavily on work efficiency, as labour costs are increasing and are expected to increase further. Therefore, logging enterprises are motivated to invest in machinery. Switching to forwarding from skidding, for instance, may increase labour costs while decreasing the number of workers, but due to the considerable leap in efficiency, the labour costs per harvested wood decrease.

This trend will be reinforced by the depopulation of rural areas. In addition, mechanisation can be beneficial from an environmental (soil protection) and work safety point of view. However, small logging companies often lack capital and a solid business history, which entails a low credit rating.

Forestry consultancy is not only the main source of technical knowledge in private forestry, but it also represents the most important organising power of the sector. Without this network of forestry professionals, it would be much more difficult to achieve forest policy and rural development objectives. Their livelihoods depend on their ability to accumulate sufficient operational area, as calculated above.

Modelling limitations must be considered when interpreting these results. In particular, the models were calculated based on average conditions, entailing that the conclusions may not be uniformly applicable in all regions with various combinations of natural and economic conditions.

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