WHAT TO IMPLEMENT? SELECTING THE RIGHT DIGITIZATION TECHNOLOGIES FOR LOGISTICS

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Abstract

The sheer amount of innovative technologies and systems and the external pressure on logistics service providers to implement these overwhelm many companies on the market. Having an effective business and being able to quantify the implementation costs, but not the benefits of innovations might let companies hesitate and thus potentially miss opportunities. This article presents a selection approach that supports companies in evaluating and selecting those digitization technologies that are best suited to reach their company-specific goals. Building on the individual company's know-how, a multi-step process filters out unsuited technologies and matches suitable technologies with their best-suited process to be applied at. Finally, a list of technologies that are most beneficial for the company is derived to build the foundation of a digitization strategy.

Key words: Innovation, innovation management, logistics, digitization

1. INTRODUCTION

Logistics have a pivotal role in economy and society, linking people and businesses to share work efficiently. Subsequently, innovations in logistics have the potential to improve supply and distribution of products, leading to lower costs or higher service levels and as a consequence to a higher level of both competitiveness (McGrath and Ming-Hone, 1996) and customer satisfaction (Khazanchi et al 2007). Vice-versa, the society does highly impact logistics, not the least by expecting that innovations are implemented in logistics. In a competitive and highly technologized economic environment, the pressure on logistics providers to adapt or even become a

first-mover is immense (see Alloca & Kessler 2006). Companies also have an intrinsic interest to be innovative, as more innovative companies perform better in a free market (Psomas et. al. 2018).

At the same time, logistics service providers face three issues, which regularly hold them back from implementing innovations. First, the sheer amount of technological and digital solutions on the market and freshly entering the market is enormous, which directly results in a lack of overview for any logistics service provider (Choi & Song 2018). This is in particular an issue, as most logistics service providers are SMEs and thus regularly do not have a dedicated innovation management unit which is responsible for identifying and evaluation beneficial new technologies. Secondly, implementing any new technology or software does come with a financial and operational risk, in particular if the newly introduced technology is innovative and thus is not a well-established industry standard (Parviainen et al 2017). Thirdly, innovations are often overhyped and their implementation does not result in the benefit hoped for (Nordgren et al 2019; Kaivo-Oja et al 2015). Driverless cars (Kolirin 2019) and flying taxis (Alvarez 2018), e.g., have been announced by government officials to be "in use soon" years ago, but are still in an early development phase and not anticipated to disseminate in large numbers within the next decade (Gessner 2020)

This paper thus seeks to address an issue that logisticians around the world regularly face: Which digitization technologies should be implemented at which time? To address this issue, a stepwise management process is proposed that systematically derives those innovations that seem to be most promising for a specific company. Following two initial steps, which are generic and not specific for the company, six main steps will be taken to filter out a small number of high potential innovations that might be best to apply for the company under review. In a post-process step, the company will then be able to internally assess the specific details of these proposed innovations.

2. INITIALISATION – IDENTIFYING RELEVANT TRENDS FOR LOGISTICS

Logistics is connecting businesses and end customers globally and thus are influenced by all parties within the network they serve (Davis et al 2006). On one hand, global, national, regional or local economic trends are relevant to logistics service providers, as they might either directly change their business model or indirectly influence them by a changed behaviour of either the end customers or the businesses they link (Wallenburg 2009). On the other hand, any societal trend might influence their own human resources, that of businesses they link or the customers preferences in a way that is capable of severely influencing their entire business model as well (L'Hostis et al 2019; Donaghy et al 2004). Finally, technological trends might open up new opportunities for LSPs or threaten their current business, as customers (both businesses and end customers) might expect the implementation of an innovation from the company (Rohrbeck & Gemünden 2011).

The global COVID 19 pandemic has impressively proven that logistics is highly dependent on trends in all these three dimensions. A changed global economy has led to a sharp decrease in demand for some goods, while other goods, such as health equipment, were highly sought after. A logistics provider that only and solely serves an industry that is heavily affected by anti-pandemic restrictions (such as, for example, fast food restaurants) would have been forced to adapt to the new economic situation and penetrate one or more other markets (Loske 2019). At the same time, COVID containment strategies like lockdowns forced millions of people around the world to stay at home. This societal change massively impacted the logistical needs, as suddenly home delivery became much more relevant for all kinds of goods, from food to consumer goods (Unnikrishnan & Figliozzi 2020). Lastly, the pandemic led to a drastically wider accepted use of videoconferencing tools, making it mandatory for companies, including logistics companies, to adapt to a new business meeting culture (Kshetri 2020).

Thus, all three trend dimensions will be considered in the following. Trends in economy, society and technology were derived from existing trend studies, namely:

- Trends and Strategies in Logistics and Supply Chain Management (Kersten et al. 2017), published by BVL International
- Technologieradar.de, an internet portal of BVL.digital (BVL.digital GmbH 2020)
- Megatrends of the German ’Zukunftsinstituts‘ (Horx 2020)
- Logistics Trend Radar, published by DHL Customer Solutions & Innovation (DHL Customer Solutions & Innovation 2019).

Finally, all trends were categorized into the three dimensions, see table 1 below.

Table 6. Dimensions and collection of relevant trends

Economic Trends	**Societal Trends**	**Technological Trends**
Cost Pressure	Demographic Change	Automation
Complexity	Urbanisation	Internet of Things
Centralisation	Multi Mobility	Big Data
Decentralisation	Digital Life	Human-Machine Interaction
Logistics Marketplaces	Awareness	
Uncertainty		
Servitisation		

The resulting collection and categorisation of trends shows extensive and partially conflicting complexes. They define the environment in which LSPs compete for business. An accurate assessment of the trends, the necessary technology to operate accordingly and a timely engagement with the topics pose a challenging task to the companies. For example, the most important economic trend of increasing cost pressure dictates much of the management’s decision making. Especially in logistics, the extremely slim margin of operations demands a constant improvement of the process costs (e.g., costs per pick). At the same time, societal trends like increasing awareness expect the supply chain to live up to high standards regarding sustainability and health of customers just like employees and suppliers. High process transparency

is necessary to prove these factors an aware society wishes for from LSPs. At the same time, technological trends allow for great improvement in processes. While this seems to be a facilitation for companies, the application of the latest technology is often expected by their customers, as stated above. Modern solutions are therefore potentially less of an advantage over the competition, but a necessity to staying in business. An example for this is the technological trend of Big Data, including the collection of massive amounts of information, but also the correct analysis of these incomprehensively large databases. If a company does not concern itself with these abstract trends and resulting decisions for technological modifications, a competing company can and will therefore offer a more effective or more efficient service.

The multidimensional landscape of trends influences every aspect of an LSP's decision making. A lacking focus on the latest trends and therefore missed opportunities to improve their service can have drastic results. An initial and simple narrowing down of the needed technologic process improvement through the filtering process proposed in this paper can avoid these outcomes.

3. NARROWING THE SCOPE DOWN: A SIX-STEP FILTER PROCESS

3.1. Overview

The aim of the designed methodology is the evaluation of digitization and automation technologies and the selection of the most appropriate and promising technologies for a logistics service provider.[1] To derive such an assessment, a multi-step process was designed. Every single step is meant to address a specific question that is relevant for the final assessment. The general approach is that of a "funnel", which initially identifies all supply chain processes and technologies, but also a number of assessment criteria. Step by step, processes, technologies and criteria will be discarded. In the end, only highly relevant technologies and processes will be analysed in further depth.

1 This methodology has been applied to a concrete logistics service provider in a specific industry

Figure 10. The proposed evaluation and selection process

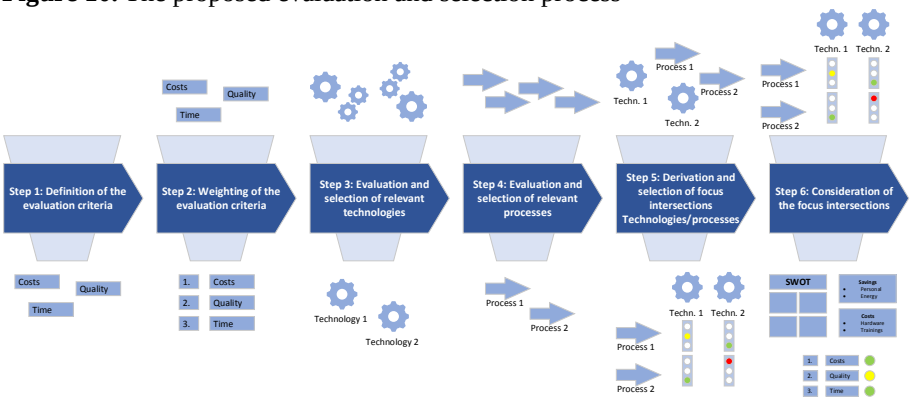

Figure 1 shows the steps of the evaluation and selection process. The methodology starts with the definition of the criteria that are used for the evaluation (step 1). To incorporate the different importance of the criteria, they will be weighted (step 2). In step 3 the previously identified technologies will be evaluated and selected, so that in later steps only a certain number of relevant technologies will be used. A similar approach is used to select those logistics processes that the method will be focused on in later stages (step 4). In step 5, the remaining technologies and processes are linked to each other, and those combinations of technologies and processes that seem to be most promising are selected. These combinations are referred to as 'focus intersections'. The final step in the proposed methodology is the detailed analysis and evaluation of the focus intersections. With the analyses carried out in the final step, the methodology leads to recommendations regarding the potential of specific technologies for specific logistics processes. The steps of the procedure will be described in detail in the following section.

3.2. The Six Steps Of The Selection Method

3.2.1 Step 1: Definition Of The Evaluation Criteria

In the first step of the introduced method, criteria for the evaluation of automation or digitization technology are identified. The LSP gathers those factors that correspond with business objectives of the company. This results in a list of beneficial outcomes, achievable by the potential application of technological innovation. It includes traditional objectives, like cost reduction or increase in flexibility, but also more complex or trending factors, like ecological sustainability or public relations. The company's representatives suggest criteria as well, if in their opinion important objectives of their business are missing from the proposed list.

The resulting collection of company objectives is necessary to cover its real innovation needs; it constitutes the basis, from which the process of the funnel is started.

3.2.2 Step 1: Weighting Of The Evaluation Criteria

In the second step of the evaluation and selection process, the criteria identified by the LSP are weighted to achieve a quantitative prioritisation of the list.

By using the method of pairwise comparison, this weighting is generated in an easy to conduct assessment, in which only two of the criteria are to be compared at a time. This list is processed by comparing all criteria in pairs, in which either the first or second criteria is rated more important, or both are deemed equally important. To achieve a wholesome prioritisation, as many (qualified) individuals as possible are to complete the pairwise comparison of criteria without communicating their assessment with each other. A possible bias of persons or parties can be avoided in this way, since the resulting weighted lists of the representatives are aggregated and form a final evaluation of the collected criteria in step 1. In general, all criteria identified in step 1 and weighted in step 2 could be used for the following evaluation process. However, to achieve a reduction in both the extent and the complexity of the succeeding process, it seemed to be both practical and beneficial to focus on the most important criteria. Thus, the n criteria deemed most important in the pairwise comparisons are selected as a basis for the further steps. Ideally, the n most important criteria on the top of the aggregated list are identified as the result of step 2 and form the basis on which both relevant technologies and relevant logistics processes are rated. In the concrete application, carried out by the authors, it was agreed upon that only the top three criteria would be used for the succeeding evaluation process, although the original list contained more than 15 criteria.

Ideally, the n most important criteria on the top of the aggregated list are identified as the result of step 2 and form the basis on which both relevant technologies and relevant logistics processes are rated. In the concrete application, carried out by the authors, it was agreed upon that for practical reasons only the top three criteria would be used for the succeeding evaluation process, although the original list contained more than 15 criteria.

3.2.3 Step 3: Evaluation And Selection Of Relevant Technologies

Step 3 of the discussed method combines the derived criteria of steps 1 and 2 of the procedure with the technologies identified in recent literature, as derived in chapter 2. These trends of digitization and automation are rated regarding their potential in the before defined criteria. This evaluation is conducted via a simple point rating: a given score of 0 signifies no potential of this technology in the respective criterion. For example, the individual identifies drone technology as having no potential impact on ecological sustainability, therefore rates it with a score of zero. The other extreme of the spectrum is a score of 5, which represents a very high potential of the technology in the respective criterion. For example, an individual sees great potential for Operations Research in the criterion cost efficiency, and therefore evaluates this intersection with a score of 5. All identified technologies are evaluated in all n criteria selected and weighted in steps 1 and 2.

In the concrete application it became clear that a general evaluation of the technologies was difficult, since some of the technologies seemed to have implications in the long run, but not in the near future. Therefore, it seems to be appropriate to incorporate a time component. The evaluation of all identified technologies in n criteria is carried out with a focus onto the short-term potential and a second time with a focus onto the medium- to long-term potential. This ensures a differentiated evaluation of two different timeframes and therefore potentials. When the authors applied the proposed methodology, the evaluation was carried out by both all representatives of the LSP and the researchers. The scientific background of the researchers and – if external party – unbiased view of the technologies regarding company culture and policy adds an important point of view to the rating of the technologies.

When all technologies are rated by all individuals by n criteria over both time horizons, the arithmetic mean is calculated for each data point. This results in a list in which all technologies are evaluated by internal and external individuals, regarding criteria and timeframes, showing those with the highest collective scores (closest to 5). The n focus technologies are selected by highest rating, focusing only onto the promising technologies that contribute most to the defined criteria. They will be further examined in the next steps.

3.2.4 Step 4: Evaluation And Selection Of Relevant Processes

The following fourth step concerns the logistics processes of the LSP and the potential to digitalise and automize them. Since a key feature of logistics is process orientation, a focus on those logistical processes is vital for evaluating of the potential of new technologies. All of the company's processes which are to be analysed are listed by its representatives. A flow chart is recommended to ensure complete coverage of the company's process landscape. (If the LSP has a business process management in place, this management system might provide all relevant logistics processes.) The evaluation of the listed processes is carried out by means of point evaluation, again a score of zero signifies an assessment of no potential at all, while a score of five is the highest potential a process could possess in either automation or digitization. For practical reasons, the processes were evaluated separately according to the potential of digitalisation and automation technologies.

During the first application, it was discussed that a general assessment was not detailed enough for decision-making. Therefore, the assessment was repeated for three points in time, respectively time horizons: the current status and both the expected short-term and medium- to long-term potential. Often, processes have a high contrast of evaluation scores between the status quo and the assessed potential, either in favour of one or the other. As a result, each process is assessed with a score from zero to five six times: three times for automation and three times for digitization. As in step 3, all involved parties and persons evaluate the processes individually. For an external executing scientific party to do so, the company and its processes needs to be closely examined beforehand, this is supported by the company's representatives. Again, the arithmetic mean of the individual assessments is formed, a collective

evaluation of the company's processes regarding its status quo and potential for innovation in digitization and automation is achieved.

The logistics processes harbouring the highest potential are again selected to be the core processes which will be considered in the further steps. An addition of specific processes that did not score high enough is possible.

3.2.5 Step 5: Derivation And Selection Of Focus Intersections Technologies /Processes

As a result of the selection processes in steps 3 and 4, company-specific intersections of technologies and processes are formed and analysed. A matrix is drawn up, consisting of the selection of the best rated items in both evaluations. The number of combinations might still be too large for a detailed examination of all intersections. Therefore, the matrix is used to identify those technology-process combinations which promise the highest application potential. For this purpose, all combinations are evaluated as to whether they promise a potential use by the executing party. A distinction is made between short- and medium- to long-term application potential. Visually, this can be depicted by dividing the cells of the matrix diagonally, assessing the short-term potential of the intersection in the top left of the cell and the medium- to long-term potential in the bottom right of it. Since the assessment of the intersections is limited to the dichotomous decision whether potential can be attested, scores of zero (no potential) and one (potential) are given to each cell twice, once for short- and once for medium- to long-term timeframe. Finally, those focus intersections are chosen from the combinations of technology and process, which show potential in either one or both of the timeframes.

These focus intersections are the result of the funnel approach, representing the combination of the most valued technology, according to company specific criteria, and processes with the most potential for application of innovative technology.

3.2.6. Step 6: Analysis Of The Focus Intersections

In the final step of the selection method, these focus intersections are analysed in depth. The application potential of this specific combination can be analysed by the use of scientific journals and literature. The strengths and weaknesses as well as opportunities and risks of the respective application are outlined in a SWOT analysis. Furthermore, the potential savings, but also the additional expenditure for the use of the technology are presented. (In the real-world implementation, the estimation of savings and expenditure was conducted in a qualitative form only. A detailed quantitative estimation depends in particular on the respective supplier of a technology and the extent of implementation; it must be conducted additionally to the selection method in each individual case, see section 4. Often, suppliers of technologies do not provide cost values without a detailed analysis of the situation at the LSP.) The analysis is followed by an evaluation of the technology application for the selected processes based on the evaluation criteria defined in Step 2. Finally, the applicability for the company is discussed among representatives of the company and the executing party.

4. POST-PROCESS: INTERNAL CASE STUDIES

The result of the six-step process designed and presented in chapter 3 is not meant as an implementation strategy for future innovations. Instead, it is a shortlist of unweighted and unsorted, but highly relevant innovations for an LSP, which might be beneficial to implement. In particular, the presented process does not involve an in-depth cost calculation or any consideration regarding the applicability of these innovations within the reviewed company.

Thus, an LSP, in a post-process step, has to do an internal in-depth case study for each and every of the shortlisted innovations. Only in such an inhouse case study, factors like factory specifics, staff key data or cost enquiries can be covered in sufficient detail to make a final management decision whether a certain innovation should be implemented or not.

5. CONCLUSION

5.1. Limits To The Approach

In each step, the LSP and its staff are surveyed to find processes, technologies or criteria that may be discarded. Thus, by design, the iterative process requires a steady and timely exchange between those consulting (internal or external), who apply the method, and the experts within the company. To achieve these desired results, there must be expert knowledge of current trends in the executing party, be it external or internal personnel.

As some of the steps rely on subjective inputs from the surveyed staff, the results will only be as representative for the LSP as a whole, as the surveyed staff is. If only a small number of employees are surveyed in each step, and potentially always the same staff members, there is a significant risk that the results will be skewed by the subjective opinion of these staff members.

To minimize such subjectively skewed output, it is recommended to involve as many members of the staff as applicable, ideally from different departments, so that various perspectives can be included. Additionally, the representatives of the company must be able to rate and describe the LSP's process landscape as close to reality as possible, the accuracy of this approach heavily depends on this assessment.

In a past conduction of the method, in which these guidelines were applied, the authors were able to give definite recommendations to the initiating company.

5.2. Conclusion

LSPs are confronted with a constantly volatile business environment. Their processes are defined by multiple trends in economy, society and technology. Many of these companies have no own R&D department – while concentrating on operational "day to day" activities, shifts in relevant technology are often ignored, as a 2019 field study showed: Of a list of digitization technologies, only cloud computing, robots and automation, and big data analytics were used in regular

operations by more than one third of the participating companies; all other technologies were used by less than 18 % (Huth, Knauer & Ruf 2019). Accordingly, these companies are less likely to be able to compete with other businesses, which apply modern technology and reap the related benefits. They never become "first movers" by barely adopting technology which has already become the standard of the industry.

When the steps of the method presented above are followed as described, a company can assess the needed technological improvements quickly and reliably, excluding underdeveloped innovations while focussing on modern solutions. The fitting automation and digitization trends are collected and matched with the LSP's processes which can benefit most from them. The method distinguishes between the short- and medium- to long-term horizon and uses the criteria most relevant to the company. The method therefore includes the company's complex details and individual circumstances. Resulting focus intersections of technologies and processes are analysed closely and recommendations regarding specific implementations can be given. It is, however, not capable of conclusively demonstrating the benefit that the technology – if deployed – will bring. Quantitative calculations must follow the application of the method, to support or decline the proposed technological reform. Nevertheless, the method at hand can filter out all technologies and criteria not relevant to the LSP and be a first step towards the implementation of innovative automation or digitization technology.

The importance of technological progress in logistics is bound to further rise in the future. Logistical service providers cannot ignore improvements in the field and stay competitive. While the current trends of the industry rapidly become the standard or remain theoretical, new trends will emerge, building on the successful innovations of the past. The most important challenge to the LSP will always be the appropriate assessment of these novelties. Any possibilities to distinguish between faulty, buzzword driven theories and real innovation, changing entire processes for the better, will only become more valuable. Exhilarating research and therefore findings expose the necessity to assess potential of technologies quickly and cheaply. The presented method, filtering trends according to individual companies, therefore will remain relevant and helpful.

5.3. Outlook

The proposed innovation assessment and selection process is quickly applicable, requires limited resources and training and provides a first insight into possibly relevant – and irrelevant – innovations for a specific LSP. Likewise, the method itself is rather simple and thus might be improved or extended in future. In particular, a cost-benefit analysis might be integrated in the process, based on estimated figures. Similarly, expert estimations regarding the availability of certain innovations and their cost development in future might be integrated in the process early on to allow a prioritization or even a timeline of future innovations to implement, rather than just a shortlist, as it currently does.

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