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«Управление проектами по принципам бережливого производства: разработка метода оценки эффективности проектного контроля»

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Abstract

This dissertation is an attempt to shed the light on the use of lean principles and tools in project based service organization and their potential meaning for project management in terms of expanding the functions of current methodology of project progress and performance measurement. In more detail, this is an exploratory desk-based research conducted to demonstrate the application of devised methodology of measuring project efficiency, grounded in key concepts of lean manufacturing, such as Overall Equipment Effectiveness (OEE), Waste identification and Value Stream Mapping (VSM). At present, numerous successful attempts have already been made to adopt lean thinking within Project Based Organizations (PBOs) in industries ranging from management consulting to publishing and IT companies (Corbet, 2007). However, the link between technical (operational) management, which lean is primarily aimed at, and project management, remains indistinct. In other words, the debates continue on whether lean principles and tools can lay in foundation of a purely *management* method. The results of the study elaborate on the applicability and significance of the learning connected with project performance measurement and provide project managers with a powerful extension of the Earned Value (EV) methodology.

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Glossary

(1) *Value Stream Map* – the simple process of directly observing the flows of information and materials as they now occur, summarizing them visually, and then envisioning a future state with much better performance' (Voelkel and Chapman, 2003);

(2) *Project Efficiency* – meeting time, cost and scope goals by optimal utilization of capital, material and human resources (Frinsdorf, 2014; Turner & Serrador, 2014);

(3) *Project Based Organization (PBO)* – a type of organization unit in which a project is the primary business mechanism for coordinating and integrating all the main business functions of the firm (e.g., production, R&D, engineering, NPD, marketing, personnel, and finance)(Hobday, 2000);

(4) *Secondary data analysis* - a multidimensional method, which implies any subsequent analysis of the dataset providing interpretations, conclusions and investigations additionally or apart from preliminary study report in general or in its particular aspects (Hakim, 1982)

(5) *Project success* – long-term utilization of the project outcome, which enables a business or enterprise to meet wider goals (Munns & Bjermi, 1996; Turner & Serrador, 2014);

(6) *Project management success* – planning and control (preferably, quantifiable) of the project, concerned with on-time delivery, within-budget expenditures and appropriate performance standards (Munns & Bjeirmi, 1997) ;

(7) *Earned Value Methodology* (EV/EVM) - an integrated management control system for assessing, understanding and quantifying what a contractor or field activity is achieving with program dollars (NASA, 2014).

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1. Introduction

The current dissertation is aimed at providing valuable insights for facilitating the learning of scholarly and practitioner aspects of project management and establishing, therefore, a platform for development of the current methodology of project control and progress performance measurement. Apart from establishing a problem-solving approach, overall, the research provides a vantage point for differentiation regarding the management practice in knowledge-intensive project based organizations, which range from management consultancy to software development organizations. In my viewpoint, the study underlines the specific aspects of the aforementioned knowledge areas as well as sheds light onto the means of dealing with common management issues: schedule deviations, process efficiency losses, and increased project lead-time.

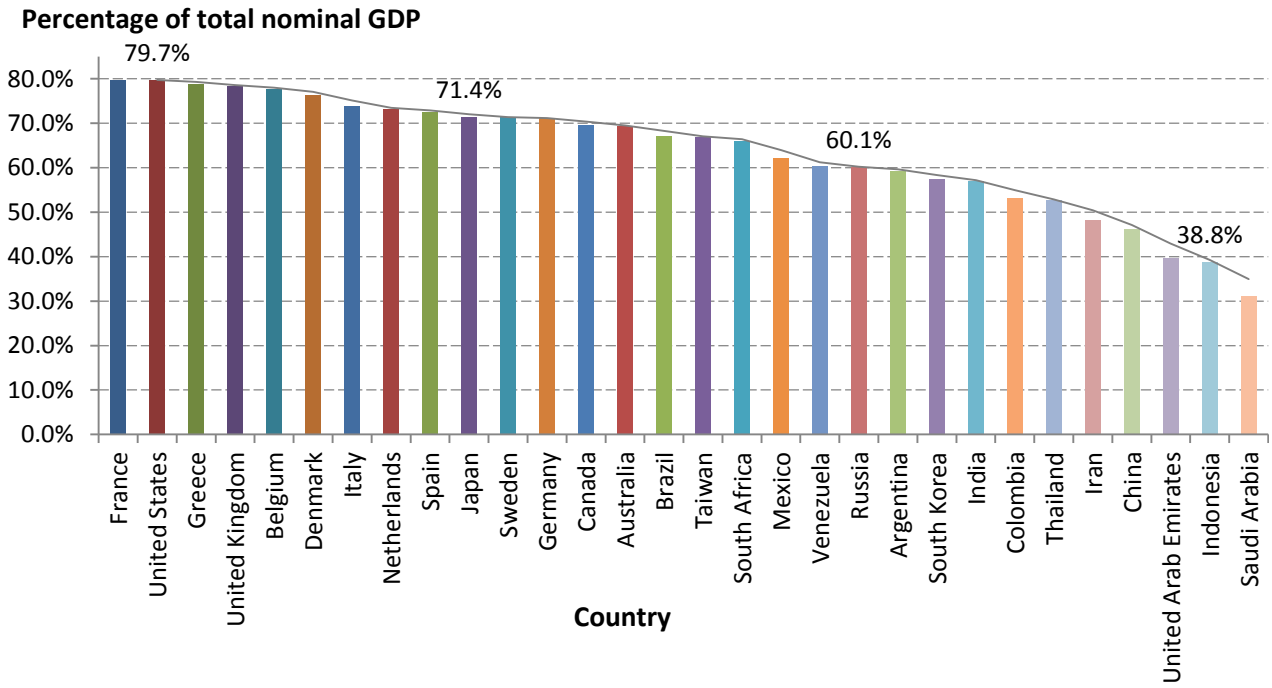
The first chapter of the dissertation is devoted to developing research focus and background. Within this section, the topicality as well as chief research aim is introduced. Further, I articulate the main objectives and essential research questions that form the context of the investigation, which are also useful in defining the scope of the study. In conclusion of the section a brief description of methodology used and the structure of the study are provided.

1.1. Research actuality and aim

Nowadays, the concept of Lean manufacturing has become a synonym for high productivity, lower cost and outstanding quality. Notably, this philosophy can be traced back to 1975 in Toyota motor company in Japan. However when competitive advantage of high in productivity, flexibility and quality Japanese car manufacturing companies

became evident, leading American companies urged to study and adopt it. "The machine that changed the world" called by Womack (1990) originally known as Toyota Production System (TPS), lean manufacturing is now a standard for more than a hundred of multinational assembly line giants, among which are IBM, Canon Inc., Bayer, General Motors, Intel, Nike, Ford, Boeing, etc.

Exhibit 1. **Nominal GDP generated by Service Industries (2012) (IMF, 2012)**



Even though lean philosophy is highly embedded in the automotive industry, which, of course, has its own specific characteristics and limitations, the hard work of both management practitioners and scholarly thought has managed to extend the applicability of lean methods far beyond manufacturing, namely, to service industries. According to data of International Monetary Fund (IMF) for 2012, service industries (non-manufacturing) account for on average 63.6% (IMF, 2012) of world`s gross domestic product (GDP), in which figures go as high as about 80% (79.7% United States, 78.3% United Kingdom) for the developed and up

to 65% for the emerging (Russia – 60,1%) countries (see Exhibit 1). Even though further in the study the heterogeneity of service industries will be explored in more detail, at this point it is important to note, that a proportion of this percentage is generated not only by services with repetitive operations, but also by contractual, unique and custom services (projects). This statistical input suggests that:

a) The applicability of project management is spreading or already had done so from manufacturing and construction projects towards service industry projects. Many service sector companies operate through contracted work, which is associated with legal, control and performance issues (accounting, consulting, market research, etc.). In such context, contrary to management of operations, "one might expect to find greater emphasis on items related to the performance of the contract to include scope change control and cost control. These are precisely the areas where the professional, scientific, and technical service organizations reported higher levels of project management maturity" (Grant & Pennypacker, 2006: 66). This highlights the definite presence of project management in service context;

b) Partly referenced from the previous point, service industries require project management methods that can warrant the delivery of the defined contractually service (i.e. project), e.g. low cost and quality deviations (Grant & Pennypacker, 2006). At the same time, service industry companies face the challenge of operational efficiency, which deals with the need for high productivity and shorter lead times (Damrath, 2012; Bortolotti and Romano, 2012) – which falls in line with the field of lean management;

c) High competition in service sectors requires a project management approach capable of remaining effective in turbulent multi-project environment (Hobday, 2000).

The aforementioned preconditions form my understanding of the relation between (1) service industry companies and project management, (2) project management and lean management fields of regulation in service context. Furthermore, an approach, combining the elements of project management and lean management appears to be a logical conduct (from the premise c), which can be defined as project management methodology aimed at delivering a project with more value and less waste. A waste is defined as an activity that does not add value to the project from the viewpoint of either external (client organization) or internal (contractor employees, project managers, etc.) customers (Arcidiacono et al., 2012). There are certain waste types for every industry or service, for instance in project management this might be creation of documentation, which is not going to be used or maintaining overly detailed schedule (PMAW, 2012). In my viewpoint, "lean project management" is a not merely a concept; it has applied nature with the potential of project optimization, keeping in mind that a project is both unique and temporary (PMI, 2004), facilitating competitive advantage for the company, which utilizes this approach.

However, when a service requires customization, i.e. it is characterized by low repeatability and high customer involvement (Shemmer, 1986), which is the case for industries like management consulting, accounting, market research, software development, design, advertising, legal and tax advisory and so on, the introduction of lean management and specifically lean project management becomes a complicated endeavor. This particular cluster of service industries is often called Project Based Organizations (PBO) (Hobday, 2000), which

underpins the temporary and variable nature of the operations – the essence of a project (PMI, 2004) – required to create value.

Specifically, the current research paper is aimed at developing such a methodological approach, which would allow project managers to define waste and numerically measure process or project efficiency, which, in turn, suggests how effective company's project management is and whether project decision-making is literate in terms of creating value for the client. Notably, the exploration of project management based on lean methods in PBO is yet poorly reflected in literature, which therefore makes this study a first step towards lean project management in service PBO.

Although the need for project control and performance measurement differs from industry to industry depending, for instance, on utilization of non-reusable materials, in information intensive service industries the use of project control loop is known to define performance, outcome and, ultimately, customer experience of a service (Upte and Goh, 2004). This, due to imperative character of the customer satisfaction for service industry (Frei, 2006), is directly related to project success (Osei-Bryson, 2009).

1.2. Research scope, questions and objectives

This paragraph deals with the process undertaken to achieve the main aim of the study.

As the research aim is very closely connected to mapping the current state of firm's processes as well as numerical indications for establishing process efficiency, the closest area of project management knowledge concerned with such aspects is project control. Therefore, the scope of the paper covers the use of classic and currently most used and recognized project control methodology – Earned Value (EV) – as well as draws on the need for its extension which utilizes a non-monetary aspect

of value or waste and allows to perform root cause analysis of major reasons for schedule deviations. This conceptual core, achieved by literature review of lean practices and methods is used to lay the foundation of a new approach.

The preamble inevitably leads to the palpitating scientific problem, verified by subsequent literature review:

At present there is no methodological approach, suited to recognize and measure project performance and indicate the prospects for enhancing process efficiency; a worthwhile extension of Earned Value.

The articulation of the problem in essence draws the red line of dissertation scope:

The study does not seek to develop either an integral organizational standards of project management or application of lean tools related to quality management – *the core problem is selection and justification of lean methods that lie within applicability to project control and is suitable for diagnostic judgment of project progress and efficiency*.

This argument is particularly important to formulate the main hypothesis that drives research interest:

A number of approaches at the intersection of lean (technical) management and classical project management are misused and therefore the essential data about project performance may not inform management decisions.

Nevertheless, to sharpen the research focus, a number of research questions are posed and followed in a coherent and evolving manner:

1. What are the lean management tools or principles and which of them can be implemented in service industries?
2. What is the essence of waste in service industries?
3. What impact does implementation of lean thinking have on:
    a. Project Success?

b. Labor productivity?

c. Work in progress (WIP)?

4. What are the current methods of measuring project performance and why lean tools can be used to form a worthwhile extension?
5. How can the dynamic diagnosis of lean-adopted techniques inform project management decisions and what insights does it have for the way in which a PBO operates?

The study seeks to address these questions in order to develop a holistic view and understanding of the problem topicality, various methodologies and the cluster of industries for which these methodologies are expected to bring about change in the way projects are managed.

1.3. Paper methodology and structure

For the purpose of achieving the primary aim of the study in a a distinct and transparent manner, I outline the structure and methodology of the study according to Collis & Hussey (2003), who offer a set of classifications using the parameters of research:

1) Purpose;
2) Methodological approach;
3) Essence of application;
4) Philosophy.

Each of the aforementioned aspects is clarified in further in detail.

As mentioned in the previous section, I regard this study as the first step towards lean project management in service companies of a particular cluster characterized by high customization of operations. In the following sections the thesis is supported by investigation of available literature, which is rare and implicit about any guidelines of such applications. This point highlights the *exploratory* purpose of the paper, which seeks to test a

hypothesis on specific company data, forming a case study, rather than providing a sufficient statistical validation across the specific industry or industries. The generalization at this point is consciously sacrificed to embark on use of proposed approach within the time scale available for developing the master thesis.

With regard to methodological approach, essentially both qualitative and quantitative methods have drawbacks and advantages. However, the logic of lean methods as well as the data available for analysis constitutes a problem that can only be solved by a *combination* of the two: at the first stage, the nature of operational outputs, such as waste and value, which is less tangible in a PBO, has to be defined and interpreted; at the second stage, the output of qualitative analysis serves as input for codification of data in project-based dataset, that is further analyzed quantitatively.

In order to be conclusive both in terms of its scientific meaning and pragmatic application, the research is *applied*, i.e. as mentioned it utilizes both primary and secondary data from a service PBO based in Russia. Even though statistically this investigation can present little interest for the general public of project management society, I believe that the proposed methodology can impact companies at similar life-cycle stage in the settings of emerging countries and additionally be suitable across project-based industries.

The research philosophy stems from the problem-solving approach, selected for the current study based on data availability as well as few relevant studies conducted in similar context. For the most part, it is *positivistic* due to desk-based essence, as it adopts the approach of the natural sciences: a proposed methodology is based on the synthesis of theory an previous studies, the new algorithm is followed and examined in-depth, while the benefits of use are presented in an objective manner as inference of hypothesis verification; however it also has classical elements of

phenomenological approach, such as illustrative case study and interpretations of interviews with company experts as one of its research methods.

Following the prevalence of positivistic philosophy, the research design is built around the three major parts:

a) Theoretical foundation for the applicability of lean techniques within management of service organizations and PBO in particular. Within this section, I elaborate on the fact that the scope of the paper is intertwined with a number of project management fields and most of all with project control. In addition, I discuss the current lean methodology (Chapter 2);

b) Empirical justification of the selected framework: the application of a devised algorithm on actual PBO data and testing research hypothesis as well as discussing the output. In lean terms this part deals with mapping the current state of the investigated scientific problem and relying on the results of this inquiry (Chapter 3);

c) Pragmatic implications and recommendations for project managers as well as indication of adjacent areas for future research (Chapter 4).

The following chapter presents the critical review of relevant literature that forms a conceptual basis of the study. In chapter three I apply the conceptual model to the data gathered from both primary and secondary sources, while in chapter four the results of this investigation are used as foundation for practical recommendations and directions of further research.

2. Theoretical foundation of Lean Project Management and its application in Service PBO

2.1.Lean management: from manufacturing to service industry

Unsurprisingly, the currently observed trend of lean expansion is somewhat similar to the chronology of its development in manufacturing, in which lean concept has undergone, first, emulation, and, decades later, after a number of major failures, second – customization and localization (Womack et al., 1990).

Since, a number of works identify the transfer of lean production techniques to service industries of repetitive operations, such as healthcare, banking, food services, insurance, education, etc. in mid 90s and further on (Womack & Jones, 1996; Kells, 1995; Swank, 2003; Radnor & Boaden, 2008). These and alike industries have a lot in common with service-oriented retail companies (Kollberg et all., (2007); Swank 2003). A case study by McKinsey & Company (Coxon et. al., 2011) is a clear example, in which the application of lean principles in banking has brought about significant positive changes (see Exhibit 1, Appendix A). The same source suggests a number of ambitious improvements made for Royal Bank of Scotland, BNP Paribas and The Society for Worldwide Interbank Financial Telecommunication (SWIFT).

The first step of this study is to evaluate its principles and tools from the viewpoint of project management. In the second step of literature review, I outline the logic of application of lean thinking in service industries, reflecting current challenges, cases and impact on performance, elaborating on the characteristics of target industry and objective limitations of lean tools, which can nevertheless be effectively applied to measure and manage projects. In conclusion, I form a specific framework that is based on

applicability of selected lean tools, which, if used in complex on regular basis, can serve as a project management method, particularly in the area of project control.

2.1.1. Lean concepts in support of project control

In the review of basic elements of lean production, it seems relevant to mention that in lean, except for philosophy and culture, the main improvements are carried out at process level, which falls into the field of regulation of project management (George et al., 2003). The summary of key principles of lean, taken from Andersson et al. (2006), is provided in Table 1 (Appendix A). Ahlström (2004) defines a 7-principle model, in which there are notable extensions: *elimination of waste, decentralization of responsibility and vertical information systems (IS)*. Each of these additional elements, combined with the classic principles of lean thinking, provides fruitful basis for the framework offered further in the study for the reasons described below.

In project management literature project control is seen as a tool to optimize (a) employee behavior to achieve organizational goals (Flamholtz et al., 1985), (b) project performance through user contribution (Liu et al., 2010). These aspects contribute to the effective management of projects through their lifecycles (Bernroider and Ivanov, 2010), i.e. lead times, which is one of the core metrics in use of lean management. These aspects bridge yet another gap between project management and lean management: (a) and (b) highlight the role of decentralization and standardization of activities as the need, which comes from within project management. Both aspects contribute to elimination of waste at process level.

In more detail, *elimination of waste* denotes that in product creation lifecycle everything that does not add value to the product, service or, in our case, project should be excluded (Monden, 1983). The notable exception

from the list of potential wastes is business activities, which are indispensable strategically for operations, although still are to be kept at minimum in total proportion of activities (Arcidiacono et al., 2012). For instance, a template for project report or new software to operate tasks may not directly add value to the project, but is vital for future success.

The aspect of *decentralization* is developed to push the responsibility down to the level of project employees (Hayes, Wheelwright and Clark, 1988). Conceptually, lean settings require a transfer to flat organization (Gunn, 1987), so that cell employees or project team in many cases has shared responsibility versus the imposed control by project manager. Leonard-Barton (1992) calls this step a must to avoid micromanagement at process level and concentrate on actual problem solving.

The role of *vertical IS* consists in "relying on direct information flows to the relevant decision makers" (Ahlstrom, 2004), which combined with shared responsibility of project team allows to update an IS and actually use the system to increase efficiency and effectiveness of managers' performance, observed by Raymond & Bergeron (2008).

2.1.2. Analytical tools

A number of tools are displayed in Exhibit 2 (Appendix A), adopted from Broughton (2012), the most general ones are briefly reviewed due to poor suitability to the framework developed in this study (Table 2, Appendix A). However, stemming from the study on maturity of project control in both manufacturing and professional service organizations (Grant & Pennypacker, 2006: 67), a number of tools are considered to suit the definition of the top level control mechanisms, which reads as "an improvement process is in place to continuously improve resource planning, schedule definition and cost control processes". Notably, this is a project

management framework that utilizes one of the key elements of lean: continuous improvement or “kaizen”.

- *Value Stream Mapping*

The bottleneck of this approach is that the essence of projects: temporality and uniqueness (PMI, 2008), which highlights the fact that only one state can be captured. Nevertheless, as for PBO projects are the primary business mechanism for coordinating and integrating all the main business functions of the firm (Hobday, 2000), there is a high possibility of repetitive elements, i.e. wastes, *across* projects. VSM then can be used to assess the repetitive elements among the projects at process or activity level and continuously update waste logs, after which project management can easily identify common waste types, locations at which they occur and dispose of the underlying reasons for their occurrence.

- *Standardization of work*

Standard work refers to standardizing the operations as well as operation sequences (Damrath, 2012). Standardization of procedures in project management is highly important, especially in the field of project control. Nidumolu (1996) advocates this statement: “…increases in the standardization were directly associated with decreases in the residual performance risk, defined as the extent of difficulty in estimating performance outcomes during the later stages of the project” (Nidumolu, 1996:135). Data collection on project performance in particular requires highly standardized forms (or spreadsheets) with data to be filled each day of project work, to estimate, for instance, earned value (EV) up to current time period (Hanna, 2012). In the devised framework standardization plays important role of reducing the volume of non-value added activities.

- *Overall Equipment Effectiveness (OEE)*

The key tool at this section is Overall Equipment Efficiency, which is OEE is “a quantification of how efficiently and effectively a company

performs compared to its designed capacity, during its scheduled run time" (Zuashkiani et al., 2011). This source suggests that this tool has already been applied for performance improvement in asset management, which is non-manufacturing context. This is highly important in underpinning the decision points for project managers. For instance, if a certain waste type, which drives a performance loss across several projects and has been observed in project history, causes a negative deviation of 10%, this may reflect the need to restructure the process to exclude such loss from the value chain.

Initial evaluation has demonstrated that the contents of lean principles and some of its analytical tools form a fruitful background for a transfer of various aspects to project management. These isolated points will be united in section 2.3, in which I attempt to develop an integral framework suitable for project control, the basis for lean project management.

2.2. Antecedents for application in service industry

Unsurprisingly, project management literature remains rather scant in application of lean principles; there are few examples in the field of scheduling (Lee et al., 2007), generic philosophy of application to project management (Gabriel, 1997); the rest of case studies pays close attention to particular projects and performance measurement, such as in construction (Yu et al., 2009), software development (Middleton and Joyce, 2012), supply chain (Arif-Uz-Zaman, & Ahsan, 2014) etc., which at the moment cannot be aggregated or generalized for wide use in project management community. Even though there are plenty of reasons behind application of technological solutions offered by lean production principles, at the moment the majority of case studies relate to healthcare, financial services, IT, insurance and other service industries of repetitive operations (Wei, 2009).

The introduction of lean principles to service industry begins with recognition of the fact, that service products differ from manufacturing

products, although not that dramatically to forbid application of lean tools, "if some peculiarities of the sector are taken into account" (Bortolotti & Romano, 2012: 514). Furthermore, Ahlström (2004) refers to cases in which the essence of services is fundamentally more suitable for lean practices than manufacturing. The followers of this view concentrate on different aspects and types of service companies, for instance Allway and Cobertt (2002) examine the meaning of alignment of processes and activities to client value creation in consultancy services, Dahlgaard and Dahlgaard-Park (2006) explore the proportion of NVA activities in total volume of activities (which turns out to be 74%).

2.2.1. Definition of a service

First, it is necessary to highlight the specific nature of services in order to be clear with further industry classifications. One of the notable definitions of a service comes from Haksever et al. (2000:3), who view them as "economic activities that produce time, place, form, or psychological utilities". To demonstrate this further, authors introduce an example of a consulting firm, which assembles all the necessary information in the form, suitable for a manager to make a decision. According to this definition, project management itself can be viewed as a service. Since there is a principal analytical difference between goods and services, it seems relevant to propose that management of these entities differs as well. The characteristics of services (Table 4, Appendix A) are taken into account further to establish management aspects of service delivery as an output product of project management in particular types of service industries, described in the next section.

2.2.2. Lean Service: cases and impact on performance

As stated, lean principles have been widely applied to service industry. Most of the cases focus on improvements in productivity, costs, waste elimination, reduction of WIP and quality deviations. The full list of publications on particular industry adopted from literature review of Suarez-Barraza et al. (2012) can be found in Appendix A (Exhibit 4).

The pioneering sector, in which lean principles have been applied, is *healthcare*. The first indications of such possibilities are summarized by Womack and Jones (1996), improvements in management and time savings are outlined by Jones & Mitchell (2006) and Lipley (2008). Commenting the findings of Kollberg, Dahlgaard, and Brehmer (2007), Suarez-Barraza et al., (2012) notes: "Lean Service was considered as one element that formed part of an overall management plan to change the mentality and the daily work performed by health-care centers", which highlights the changes related to particularly management aspect of operations. There are other management examples, which are facilitated by lean projects, for instance Dahlgaard et al. (2011) proposed self-assessment framework (ILL), which turned out to be valid in identification of organizational bottlenecks. In general, primary target of lean transformation projects in this sector are inadequate procedures and bureaucratic processes, which decrease the quality and rate of customers served per shift (Collins & Muthusamy, 2007).

Another sector, in which lean principles turned out to be highly applicable, is *education*. The majority of studies (Dahlgaard et al., (1995); Kells, 1995; Suarez-Barraza et al., 2012) indicate that main improvements in this sector relate to Total Quality Management (TQM) and waste elimination. Again, the restructuring of processes based on information flows, provided by lean analytical tools, "helped to improve the management of services" (Suarez-Barraza et al., 2012: 370).

As indicated in introduction, *financial and banking* sectors also fall into the sphere of transfer to lean management. Swank (2003) elaborated on

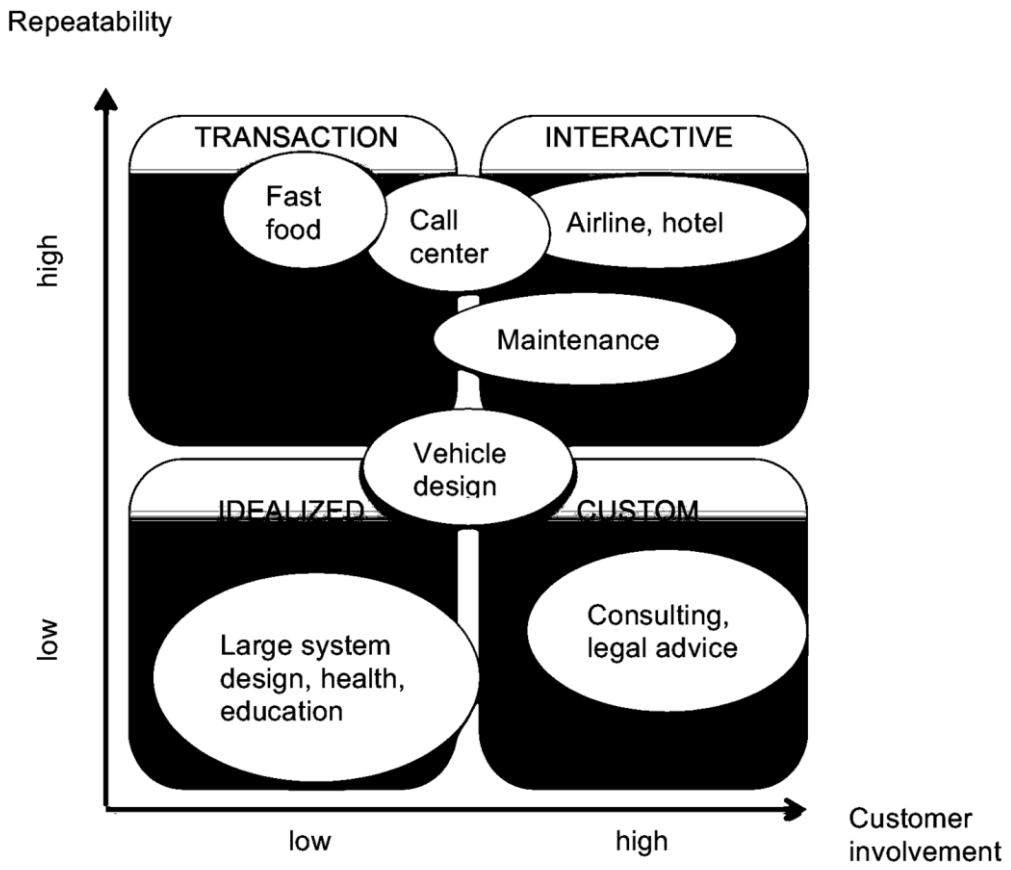
the result of process redesign as “surprising” due to decrease at 26% in labour costs and 40% in costs related to errors, rework and corrections. A study of global investment bank by Coxon et al., (2011) has shown an increase in productivity by 50%, while the volume of documents with errors reduced by 40%.

Significantly less academic papers can be found about *airlines, restaurant and hotel services*. The commonality between these industries is high process repetitiveness and high customer interaction. The practitioner studies of application of lean principles to restructure and reorganize processes in airline industry (Greenwood et al., 2002; Reinhardt, 2007) enumerate savings and reduction of lead times, while Suarez-Barraza (2008) reports on reduction of operating costs, client-response time and the quality of service in hotels and restaurants.

2.2.3. Differentiating among service industries

Given the specifics of a service as an output product of a cluster of industries, it is vital to define these segments, explore the extent of lean spread within them and establish target industry. As described in the methodological introduction to the study, service sectors can be clustered based on repeatability of processes and customer involvement. Schemmer (1986) first proposed a matrix with these dimensions, which incorporate common problems during service production and delivery. The dimension of repeatability refers to common stages and processes, rather than activity level, while customer involvement stands for the frequency of interaction with external customers (Damrath, 2012). Even though this framework is simple and plain in contents, it allows investigate the spread of lean principles by gradations and define the industry of interest (see Exhibit 2).

Exhibit 2. **Service industry matrix (based on Bicheno, 2008)**



Even though in reality the boundaries between formulated categories can be fuzzy, four distinct clusters can be characterized (Damrath, 2012). The detailed description is provided in Table 3, Appendix A).

The overview of cases on application of lean principles in service industries (section 2.2.2) has shown, that practically every sector has been attempted to transfer to lean, except for the custom one, characterized by high customer interaction and low repeatability, which forms a direct link to project work and PBO. This is one of the primary reasons why it has been chosen to concentrate on companies operating in this gradation, especially with regard to potential positive outcomes for management of projects.

2.2.4. Challenges for the custom cluster

As described, the custom cluster has low repeatability of operations (high uniqueness) and higher customer interaction, which provides connection with project work (PMI, 2004). One of the main challenges for custom service sector is to follow the footpath of manufacturing in terms of reduced project lifecycles (Damrath, 2012). As a result of increasing competition in service industry in general with high rates of innovation and know-how, faster response to market conditions and management of operations is required by service business models and processes (Sellitto, Borchardt, & Pereira, 2003). According to Upte and Goh (2004), who investigated management aspects of lean in information intensive service industries, such as mentioned contract working management consulting, accounting, market research and other PBO, the processes could be managed with the tools, which are applicable to manufacturing processes (particularly bottleneck identification and cycle time analysis). However another aspect of information intensive services remains unnoticed: feedback control loop, which denotes that generated information is suitable for "the measurement, monitoring, and control of process performance. …The efficiency and the effectiveness of information processing activities in collection, transformation, storage, use and dissemination of information determine the ultimate performance and outcome of such services" (Upte and Goh, 2004: 493).

Another argument for the use of information generated within projects of service organization to manage operations is voiced in the study published by Ahlstrom (1998), in which author insists on constant monitoring of processes using relevant metrics. In absence of such tools processes can degrade and decrease customer satisfaction. Yassine et al. (2004) suggests that a technique that uses workflow data can be widely used to manage a process. Bortolotti and Romano (2012) consider this proposition "useful to

improve efficiency and lead time performances with faster information exchanges, faster task execution and concurrency of tasks" (Bortolotti and Romano, 2012: 519).

Overall, these arguments suggest, that perhaps the main management challenge for many organizations in custom cluster of service sector is meaningful data for sufficient decision-making regarding process structure and value creation stream (Damrath, 2012). At the moment scholarly literature (George, 2003) suggests the impossibility to verify the quality or speed of processing in any other metric, except for actual time to complete the task (or cost), while any other indicator can be referred as judgmental and subjective. However many companies do not manage their processes with regard to quality or processing speed even using this metric; rare examples of managing these two parameters include excel spreadsheets (Archibald, 1992). The need for project management technique (since projects are the primary form of business operation for companies of this sector (Hobday, 2000)), which can cope with the challenge of combination, analytics, dissemination of workflow information in a clear, accessible and understandable way is evident. Upte and Goh (2004) back up this suggestion with the proposition of relevant metric - *the cycle time for completion of a service request*, i.e. contractually defined project. A related study by Blackburn (1991) indicated, for service companies at that time about 90% of cycle time is occupied by first and most dangerous waste described in lean principles – waiting time.

The important preconditions for adopting lean techniques in project control, which would operate with the mentioned indicators - elimination of certain wastes types and consequent cycle time reduction – are set by the synthesis of practitioners' cases and scholarly arguments above. One of the resulting definitions of a service suggests that customer experience is as important as the output product itself. Frei (2006) suggests that this point in

application of lean techniques is of utmost importance, as the increase in process efficiency can discard customer satisfaction, which in long-term may offset any discrete competitive advantage, profit or market share (see Bortolotti and Romano, 2012). Some scholars insist on VSM being the most important lean tool to adopt in service sector (Piercy and Rich, 2009).

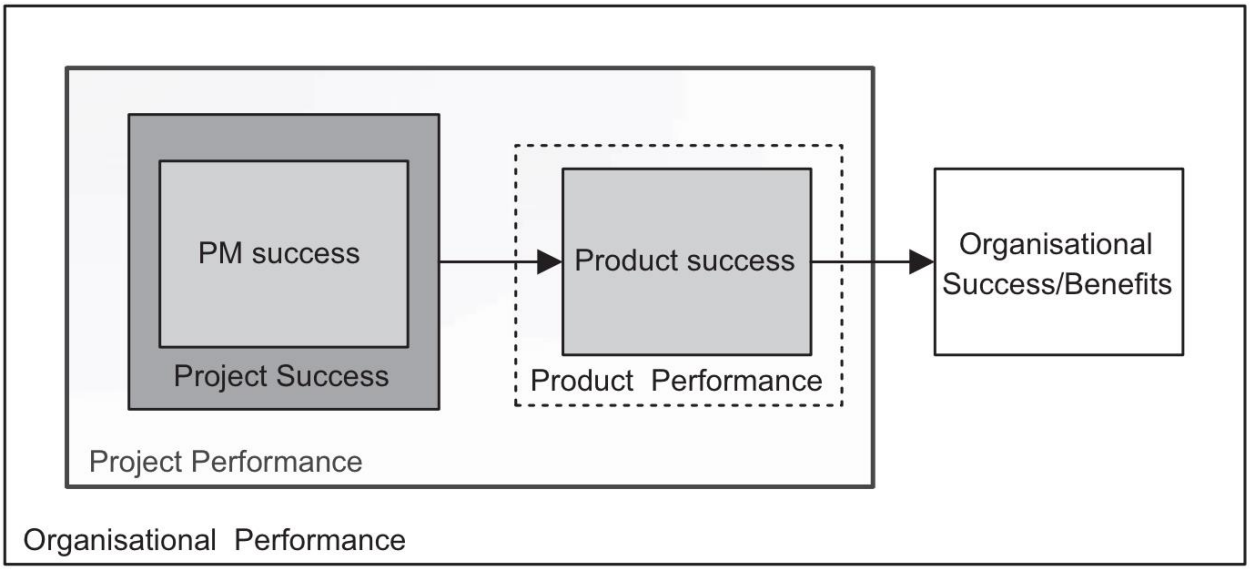
2.3. Towards lean project management: framework of the study

The scope of the framework developed in the study is closely related to the field of project control and project performance measurement, defined as the aggregate identification of process efficiency. Even though the debates over the optimal control mechanisms of projects is still ongoing, some authors readily confirm that the use of "iron-triangle" paradigm is no longer viable (Atkinson, 1999; Shenhar et al., 2001; Yu et al., 2005; Barclay and Osei-Bryson, 2009). The alternatives suggested to overcome the restrictions of classic methods of project control (such as critical success factors (CSF), key performance indicators (KPI)) are considered to be concentrated on either side of value definition (Yu et al., 2005; Barclay and Osei-Bryson, 2009). This aspect is somewhat common between project management and lean schools of thought.

The project management idea of value differs from the business (economic) definition and consists in an allocation of project budget often expressed in currency or time. The tool aimed at control and estimation of project performance is most often earned value (Yu et al., 2005; Cioffi, 2006; Lauras et al., 2009). A number of significant additions have been made as for the EV methodology and other monitoring tools, some of which sought to either extend the parameters of "iron triangle" or reduce them (see Khosrowshahi. 1997; Shenhar et al., 2001; Lipke 2003), however the overall approach remained mainstream comparison of budget to actual cost of activities. This school of thought also learned to distinguish between project

management success, project success and output product success as important dimensions of project performance measurement (PPM) (see Exhibit 3, adopted from Barclay and Osei-Bryson (2009)). These aspects are developed further in sections 2.3.1. and 2.3.2.

Exhibit 3. **Project Performance Measurement dimensions (Barclay and Osei-Bryson, 2009)**



Since projects are temporary and unique activities that result in a new product or service (APM, 2006; PMI, 2004) a transfer of lean thinking from lean service examples, discussed earlier with particularly management ability to diagnose process efficiency and restructure processes as a result of such diagnosis, project management as a science may well be subject to intervention for some tools from manufacturing and service sectors (section 2.3.3.) There are numerous examples of lean techniques that were used in transformation projects of both manufacturing (Boeing, Alcoa) and service sector, however these techniques and methodologies were primarily considered as objects (or facilities) of change, while there are still no scholar or practitioner suggestions that they have become a project management methodology (i.e. subject of change).

In my study, I refer to project based organizations (PBO) as perfect settings for such transfer due to, first, their prevalence in custom cluster, but also because of:

a) Multi-project environment, in which single projects compete for organizational resources (Frinsdorf et al., 2014);
b) Difficulties arising from poor operationalization of value and/or waste within particular projects and numerical measurement of these parameters;
c) The difficulty of attributing performance attributes (e.g. flexibility, effectiveness, efficiency and return on investment) to particular factors such as organizational form (e.g. PBO) or industry-specific forms of projects, rather than other factors (e.g. project team, stakeholder management, company culture, etc.) (Hobday, 2000)

One of the main reasons for adoption of lean principles in custom cluster is that the function of performance measurement is not only in monitoring, but also in learning and improvement (Wegelius-Lehtonen, 2001). Project-based structure of many companies in custom sector perfectly allow this idea to proliferate in business processes and PPM tools, accompanied by knowledge collection and distribution mechanisms in the form of information systems (IS) (section 2.3.5).

2.3.1. Earned value

At the moment, the area of project control has only one widely utilized tool for tracking project performance, the Earned Value (EV)(Pajares and Lopez-Paredez, 2011). The tool was introduced in late 60th and since a number of amendments, such as Earned Schedule (Lipke, 2003, 2004), had been made, a lot more provide an estimation of tool accuracy (Vandevoorde and Vanhoucke, 2006, 2007; Lipke et al., 2009). Notably, the EV methodology has numerous benefits and I by no means suggest that it is

either outdated or inappropriate, however it has not been tailored to any specific industry except US military service, which is the birthplace of the method.

The method uses three estimates of costs – budgeted, actual and scheduled to measure how much value should have been earned (or, rather, how much should have been spent) at the moment of measurement. High tool validity is assured by its forecasting power regarding budget cost at completion with current dynamics and underpinning of time-dependent deviations. At the same time, the universal character of this tool has led to a number of drawbacks, among which are:

- Voluntary root-cause analysis (RCA) of reasons behind deviations;
- No iterative approach to scheduled and budgeted costs (i.e. no optimality check of resource allocation);
- Misleading indictors (SPI and SV) towards the final third of the project (Lipke, 2003).

The aforementioned extensions of EV, such as Earned Schedule or fine-tuning of accuracy have mended some of the calculation problems (third aspect), however first two aspects at the moment are left without common problem-solving approach.

Using suggestions of Seddon & Caulkin (2007) and Piercy & Rich (2009) to mend these problems, I will use the two lean tools, which are specifically aimed at resolving first and to some extend second drawbacks of EV: Value Stream Analysis and Waste identification.

2.3.2. Relation to project and project management success

Since relation to project success is one of the key metrics developed in PPM over the years (Osei-Bryson, 2009), the conceptual framework of the study has to conceptually tight the aim of the study (project management

success) with overall success of the project. I will define the two concepts first:

- Project success – long-term utilization of the project outcome, which enables a business or enterprise to meet wider goals (Munns & Bjermi, 1996; Turner & Serrador, 2014);
- Project management success – planning and control (preferably, quantifiable) of the project, concerned with on-time delivery, within-budget expenditures and appropriate performance standards (Munns & Bjeirmi, 1997).

Classic studies on this subject, for instance Munns & Bjermi (1997), Belassi & Tukel (1996), suggest that project management alone cannot define project success. However there is evidence that good project management allows avoiding project failure. The same sources denote that higher customer involvement "in planning and production phases" helps to meet wider objectives, i.e. also influence project success.

Additionally, project management considers traditional parameters of projects, i.e. time, cost and quality (PMI, 2004), while project success highlights objectives of project stakeholders (Cooke - Davies, 2002). The combination of the two sets of criteria is believed to be suitable for improved analysis of project performance and considered as guidance pulled from the literature (Osei-Bryson, 2009).

Notably, lean perspective helps to develop such a combination due to its orientation on "voice of the customer" (Griffin and Hauser, 1993) or "customer perspective" (Kaplan and Norton, 2004). It appears that customer/stakeholder requirements develop the understanding of value/waste on the level that controls for key "iron-triangle" parameters on condition that they are suited to create customer satisfaction. In the papers, which discuss Lean Service cases, there is often no mention of whether the project outcome is success or failure, however using logical deduction from

generous increase in productivity, reduction of lead times, cost effectiveness, etc., it is evident that either the majority or all the stakeholder requirements lead to customer satisfaction. Additionally, the voice of the customer can come both from inside and outside the project or organization. Therefore, principles (1) and (2) in Table 1 (Appendix A), are the primary elements, which are used in conceptual framework of the study.

2.3.3. Process efficiency and value stream: towards effective Project Management

Methodologically, the framework of the current study is aimed at providing an approach assembled from lean tools suited to diagnose process efficiency using practically the same inputs as used in EV methodology. The main difference, however, as described in section 2.3.1.. is that my approach allows to highlight the bottlenecks of processes, which facilitates action-based improvements.

Process efficiency, if separately considered, consists in meeting time, cost and scope goals by optimal utilization of capital, material and human resources (Frinsdorf, 2014; Turner & Serrador, 2014) and is an object of technical construction of a process, which cannot be considered a project management method. However, if the input for such tool comes from project stakeholders, and the tool itself is used primarily to control the planned resources (the way EV does), then this newborn method becomes suitable for:

- Project control;
- Performance measurement (planned vs. actual time, products, resources spent on tasks);
- Optimization (elimination of non-value-added activities).

The proposed methodology consists in application of Value Stream Analysis, which, in essence, allows more transparency in value creation process. Exhibit 5 (Appendix A) shows that there are two basic characteristics

of processes: total lead-time and value added time (a ladder in the bottom of the picture, see the full list of abbreviations in Exhibit 6, Appendix A). The visual map of processes allows identifying certain waste types, which immediately informs management decisions on restructuring a business process, therefore reducing lead-time and increasing value-added time. The necessary comparison of these indicators among projects by means of calculation OEE helps to see the overall process efficiency level across different projects.

The incorporation of such tool in the process of project control and performance measurement will allow projects to be managed more effectively, i.e. doing the right things, selecting and focusing on producing an output that there is a demand for (Sundqvist et al., 2014).

2.3.4. Management and learning aspects of proposed approach

The proposed framework (Exhibit 4, section 3.1) is aimed at one of the most basic forms of management as a science – control. Importantly, project control allows using lean principles to holistically scrutinize the root causes of process inefficiencies, which means that this is jointly a tool for optimization. One of the main suggested outcomes is that management decisions should be aimed at not only monitoring the current state, but also at developing a more efficient high value-added processes by means of reduction of lead times (Bortolotti and Romano, 2012). This means, that streamlined activities that drive value and exclude waste shorten the time required to complete a service request, i.e. a project. In turn, this means that a PBO can process more projects at a time period without any detrimental effects to project quality, which is in line with the constant strive for competitive advantage between project organizations (Lindkwist, 2008).

In such circumstances, there are some characteristics of services that can cause negative deviations in project performance, for instance

homogeneity in IHIP framework (Table 4, Appendix A) denotes, that deviations in performance depend on human operator. Another negative affect can be drawn from perishability of services in the way that a completed request has to be somehow reflected, depicted, and systematized in order for organization to be able to refer to it when needed.

The answer to these as well as other specifics of service industry is organizational learning. A recent study by Pemsel & Wiewiora (2012) concludes, “PBO has to ensure effective knowledge sharing (KS) and integration within and between projects to avoid the risk of reinventing the wheel and so repeating the same mistakes“(also noted in Schindler and Eppler, 2003). Project-based learning is commonly referred to as 1) the creation and acquisition of knowledge generated within the project, and 2) the codification and transfer of knowledge (Scarbrough et al., 2004). Undoubtedly, project-based learning has to be institutionalized, i.e. transferred into a continuous process, which would allow a PBO to constantly evolve in their practice. In doing so, an organization would have to transform or even create from a scratch the mechanisms of codification in a most simple, reliable and accessible way. Essentially, the use of knowledge or information systems is one of the preconditions for adopting lean methodology (see section 2.1.2), and many scholars already emphasized the need for project learning in the process of control and monitoring (Wegelius-Lehtonen, 2001; Upte and Goh, 2004; Ahlstrom, 2004; Raymond & Bergeron, 2008).

The next chapter of the study is aimed at providing empirical justification of the proposed framework, testing the basic hypothesis of the study (section 1.2).

3. Mapping the current state: empirical justification of proposed methodology

Theoretical overview of the key concepts of the research, case studies on the use of lean in service industries, drawbacks of current methodology and the challenges faced by a PBO in the custom cluster has narrowed the need for improvement and optimization down to the project management methodology with elements of lean. The evidence of both the need for and absence of methodology, suited to perform the two functions of project control and project performance measurement, has been presented in the previous chapter. This chapter is designed to empirically test the proposed framework on the data provided by a market research PBO.

3.1.Methodological framework

The methodological framework is a technical guideline for the theoretical framework of the study. In this section, first, the overall logic of data analysis and sampling is described; second, I outline the main hypothesis of the study and, third, I proceed with research objectives.

The application of lean tools within project-based cluster of industries is yet poorly explored in both literature and empirically, which highlights a methodological complexity associated with:

1) Adaptation of the philosophy of constant processes and operations to temporary and variable operations;
2) Control and Information Systems. If we regard project management as a control system, then the temporary knowledge generated within a project has to be captured and distributed to inform management decisions; this particular point constitutes a controversy with lean thinking, which emphasizes elimination of

unnecessary control and embedding it within the [stable] system (Ohno, 1988).

The aforementioned parameters drive this study inevitably towards process and activity level, which goes hand in hand with the terms of effectiveness and efficiency as well as overall project success - all of which are the hallmarks of lean manufacturing principles (Upte and Goh, 2004; Kaplan and Norton, 2004). Process level is also the key element of lean management regarded as a tool for optimization by first and foremost concentrating on elimination of waste, defined as any activity that does not add value to the end product. The essence of value in this study is considered from the viewpoint of internal customers, i.e. project team members that create value based on client specifications. Based on the Toyota Production System principles, this study seeks to resolve company's internal contradictions and gaps in value creation process by offering an applied management tool of measuring project performance. The emphasis on VSM, as well as key indicators suitable for performance measurement in service environment comes directly from the literature and serves as conceptual basis of the devised framework (Exhibit 4).

The research design, following the devised framework (Exhibit 4) is multiphased. The first stage consists in developing the specific understanding of either waste for the chosen company by means of qualitative methods, specifically – interviewing company experts. In the current paper, I have chosen to study waste types due to inability to reach company clients and project stakeholders, which is the result of:

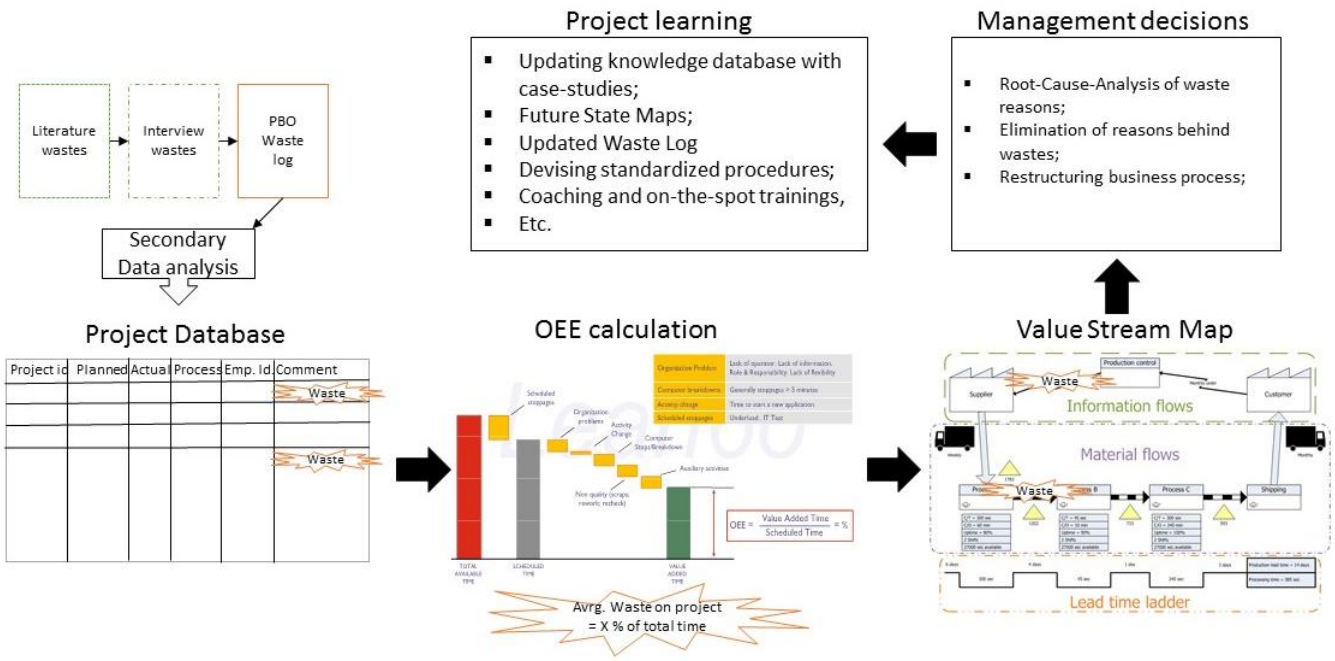
1) Dataset collection took place in the past and was performed by company management;
2) The research is external to the PBO, which deals with data sensitivity and confidentiality to open sources.

Accounting for the service industry waste types found in scholarly literature (Bonaccorsi et al., 2011), an interview guide was developed (Part 1, Appendix B) in order to assess the classic waste types (Table 5, Appendix A), cross out the unnecessary ones and add industry and process–specific wastes.

The second phase draws on the waste log, assembled during the first phase, to perform secondary data analysis of company's dataset in order to define the proportion of wastes across processes. Secondary data analysis represents a multidimensional method, which implies any subsequent analysis of the dataset providing interpretations, conclusions and investigations additionally or apart from preliminary study report in general or in its particular aspects (Hakim, 1982). This means that the company in question did not previously used or assembled the dataset for the purposes described in this study.

During the third step the repetitive processes across and within projects are analyzed using Overall Equipment Efficiency (OEE) for the reasons described in section 2.1.2. This method represents a Total Productive Maintainance tools and visually represents process losses/wastes independently of the whole system, in which the process is integrated.

Exhibit 4. ***Framework of the study***



The fourth stage is performed by depicting a Value Stream Map, specifically – current state of process alignment and flow. This technique is adopted in order to provide inputs for root cause analysis of process inefficiencies, which form a platform for management decisions.

3.1.1. Research hypothesis

The main hypothesis of the paper consists in proposition that a methodology assembled from lean tools and following lean principles can be used to measure project performance in service PBO (H1). The sub-hypotheses of this proposition are:

1) Average project lead time can be reduced by at least 10% by means of waste elimination (H1.1);
2) Average process OEE is below world-class figures (85%) (Arcidiacono et al., 2012) (H1.2);

Testing these hypotheses is helpful to demonstrate the diagnostic power of the devised methodology in addition to ability to be utilized to measure project progress as development of EV methodology.

3.1.2. Main goal and objectives

The main goal of the study is to develop current methods of project control and project performance measurement in order to inform management decisions on project structure, resource allocation and optimization. The following objectives have to be addressed prior to achievement of research goal:

(1) In theoretical field: synthesis of generic waste types in lean manufacturing and lean service to provide input for interview guides used to survey company experts.

(2) In practical application:

(a) Devise a semi-structured interview guide and screening questionnaire to assess common waste types and assemble waste log;

(b) Interview company experts;

(c) Data analysis and interpretation: Secondary data analysis; visual representation of process OEE; Depicting Current State Map.

In my viewpoint, these objectives will facilitate hypotheses validation and take the study directly to achievement of the main goal.

3.2. Data analysis

The process undertaken to acquire secondary as well as gather primary data is provided in section 3.1. The main findings of the study are presented in this section. During the first step, I outline the common characteristics of empirical data (3.2.1), while further sections pay close attention to the contents and interpretations of the output of each phase (3.2.2-3.2.5), drawing on identified specifications and frameworks, used as theoretical basis of the devised framework.

3.2.1. Sample and dataset characteristics

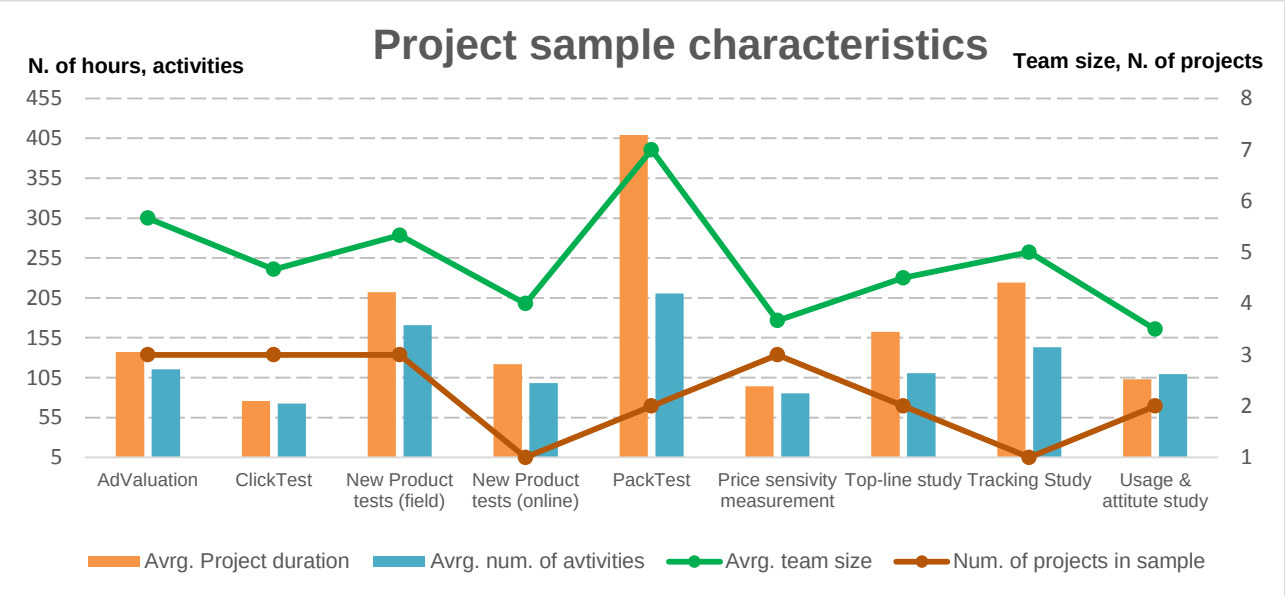
The dataset is taken from longitudinal study carried out by one of the leading Project-Based Russian market research company in IPSOS group, in which a project for internal monitoring purposes was held in 2012, during which all employees filled in daily timesheets indicating:

1) Date;
2) Activities and processes to which the activities belong;
3) Time estimate for the specific activities by project manager (calculation of Total Available Time);
4) Actual time required to complete the task;
5) Project ID;
6) Project methodology;
7) Employee comments.

The dataset itself was collected in Moscow, Russia. Sample size is 23 500 observations, which represents about 700 projects within the time scope of one year and seven month. The main input for secondary data analysis as interpretative qualitative methodology is contained in the comment section, in which main issues, activity contents and characteristics are described, and which, in majority of project cases, remained blank. This characteristic of the dataset extremely limited the number of projects, suitable for analysis.

Total number of projects, reviewed via the secondary data analysis contains 20 observations (Exhibit 5). All projects are divided into several types, ranging from ClickTest (Online questionnaire for testing how appealing the product is) to PackTest (Study of the devised alternatives to current form-factor of product package). Consequently, the selected projects differ by size, complexity and methodology offered to the client, which should be valuable in terms of building an unbiased and holistic perspective of analysis.

Exhibit 5. ***Characteristics of analyzed projects***



During the first stage, which required gathering primary data, I conducted a total number of six interviews with company experts, all of which worked for various projects in the company and have been part of the committee, which initiated the project of internal monitoring.

3.2.2. Qualitative stage

The first stage of qualitative stage is sampling. According to Marshall (1996: 522), "an appropriate sample size for a qualitative study is one that adequately answers the research question". This strategy was used to build *theoretical sample*, which, prompted by the main goal of the research, aims

to advance project management, i.e. project control. This is why all observations were gathered from project managers and coordinators, directly involved in the process of project control across projects of the company. The validity of semi-structured interviews is considered to be high (Bariball and While, 1994), although, as any qualitative method, it does not provide the level of generalization, required of any quantitative technique. Therefore, the results of the study are confined to the specific company data. The validity of interview data in this study is based on:

1) Personal and professional acquaintance with interviewees, which sets mentally comfortable and constructive interview settings;
2) Professional acquaintance with working conditions, projects and project management of the company (previous employment);
3) Interviewee motivation to use the output of the study in enhancing current project control methodology of the company.

All interviews were recorded and then transcribed for the purposes of data analysis. Research ethics was closely watched, taking interviewee's consent for data processing, anonymity and confidentiality of data provided.

The interview guide contains five sections, in which organizational context, project management, project and process efficiency as well as organizational learning aspects are reflected (Part 1, Appendix B). A screening questionnaire was also prepared as supplementary material for interviews (Part 2, Appendix B).

The main findings of each section were organized in a table, which depicts a synthesis of waste types, experienced by interviewees (Table 2 and 3, Appendix B). To summarize, the proportions of waste categories in accordance with Table 5 (Appendix A) are depicted in Exhibit 5. This chart

evidently shows that the structure of waste in the company is highly fragmented, with Duplication/Rework, Waiting and Motion forming 54% of total structure. This suggests, first, that project resources are poorly utilized and these problems deserve close consideration by itself, and, second, that there is, in fact, cross-project set of wastes, that can be assembled, updated and looked at when filling in timesheets, necessary for calculation Earned Value.

Exhibit 6. ***Structure of Waste log assembled through interviews***

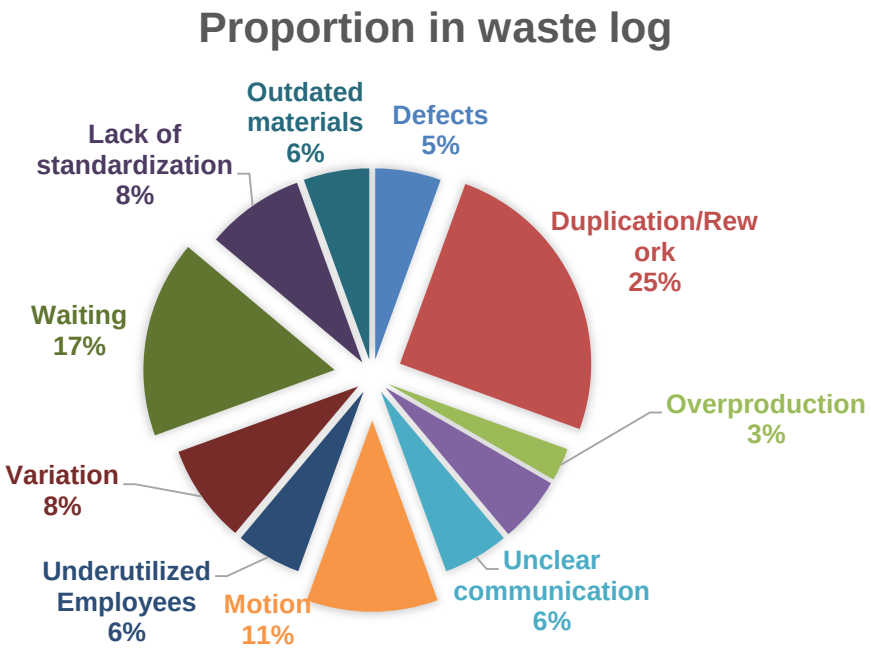
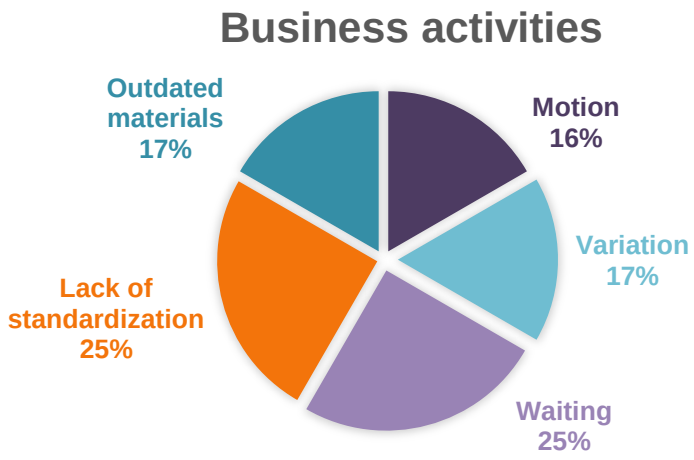


Exhibit 6 shows the structure of business activities (the ones that are wastes, however are necessary for business functioning), which in total constitute 34% of total number of waste types. The proportion of business activities straight away is high; however, this only regards general mentions in the interview, which does not reflect the actual proportion in project processes.

Exhibit 7. ***Structure of business activities***



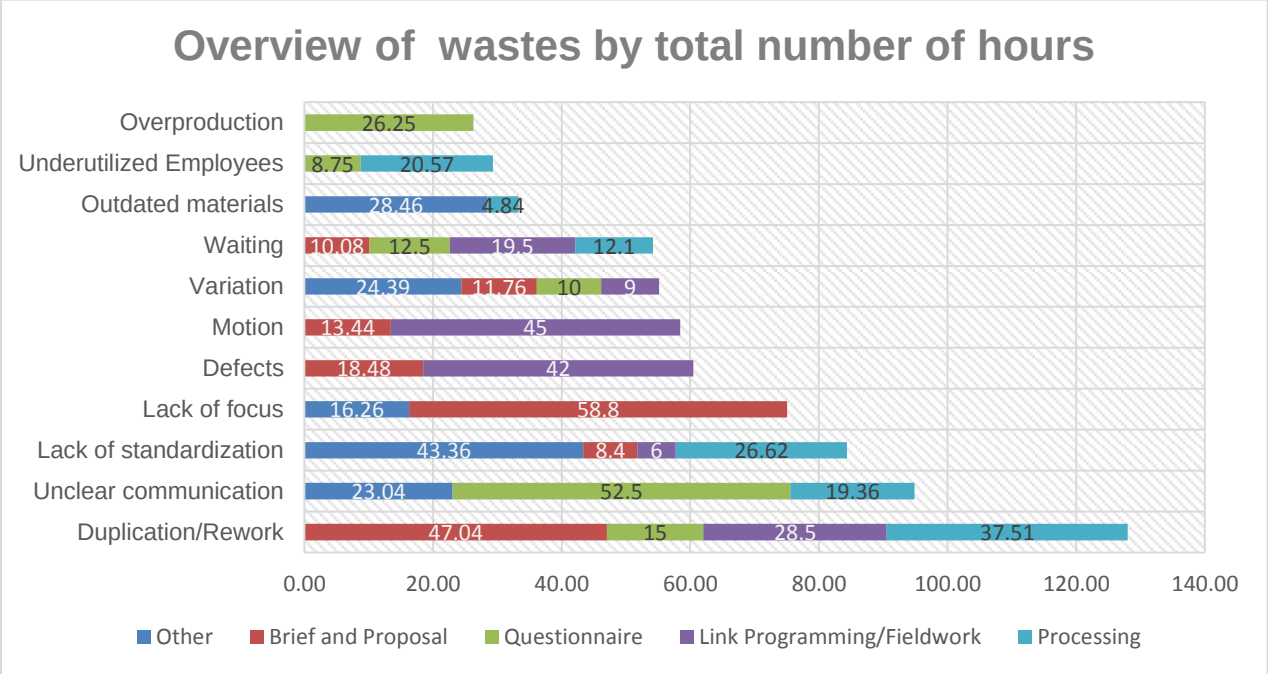
3.2.3. Secondary data analysis

This stage of data analysis consisted in assigning waste type codes to activities, which contained comments about activity content. In total, the deviation between actual activity descriptions and waste definitions, presented in Table 3 (Appendix B), turned out to be low, which means that the majority of descriptions highlighted specific characteristics of defined waste types. In Exhibit 7, each waste type is shown according to the total number of project hours (Supplementary materials are shown in Table 4, Appendix B).

The key findings from Exhibit 7 consist in definition of four most dangerous waste types for company projects and processes: (1) Duplication/Rework, (2) Unclear communication, (3) Lack of standardization and (4) Lack of customer focus. Drawing from IHIP framework (Table 4, Appendix A), wastes (1) and (4) may represent the characteristics of perishability and intangibility accordingly. In other words, significant amount of rework is connected to inability to store a ready service or lack of customer focus as another reason, where the latter, in turn, can stem from promised performance and client internal conflicts resulting from incomplete understanding at project initiation phase (high proportion of brief and proposal processes). Waste (2) is most often seen at

questionnaire stage, where organizational communication channel seem to be highly ineffective. Lack of standardization is most often at other project processes, which is usually pre-proposal stage, concerned with winning a client and giving paper documentation for prices, project details and other contractual information.

Exhibit 8. ***Overview of waste types observed across projects***

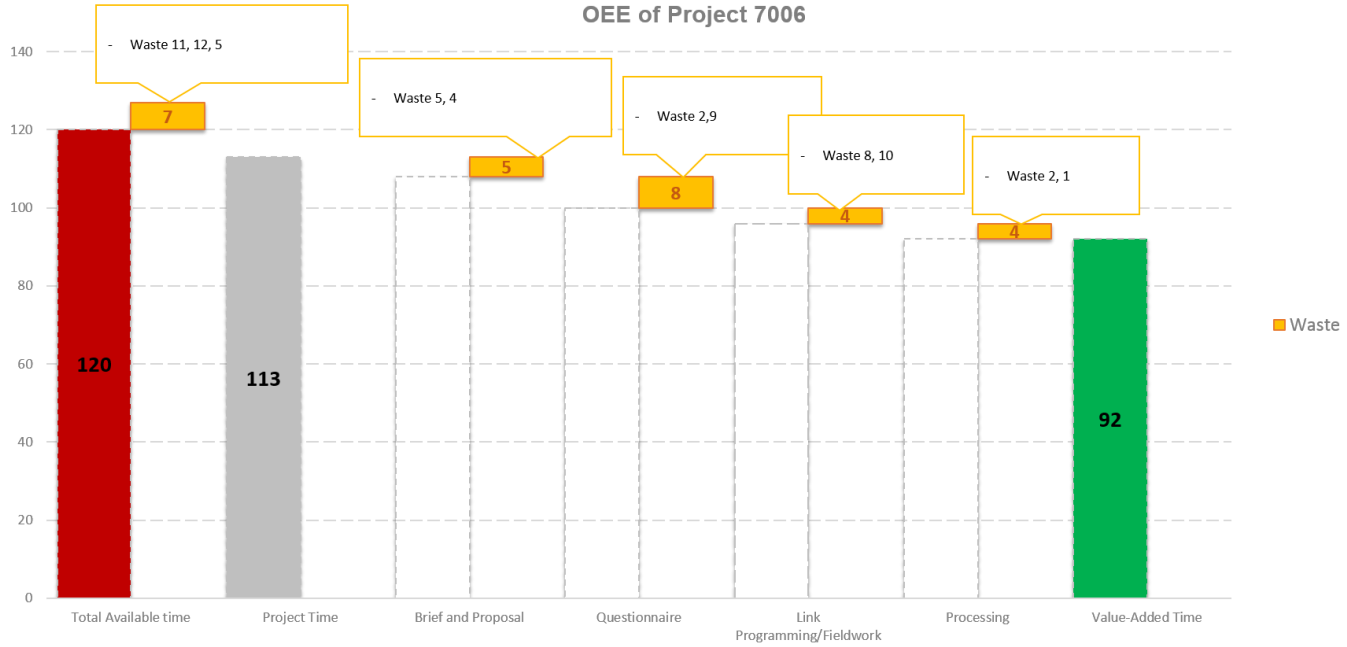


Another significant point is that secondary data analysis did not allow to split waste types from business activities, which happened because short comment and incomplete sections of project monitoring dataset. Nevertheless, in terms of control of waste occurrence and underutilized value in time or currency equivalent this type of analysis turned out to be suitable.

3.2.4. Quantitative stage: OEE project overview

The devised methodology allows depicting efficiency of either a process or a project. Since I search for an aggregate measure of project performance, I depicted OEE of both a particular project (Exhibit 8) and across projects (Exhibit 9).

Exhibit 9. ***Single project OEE***

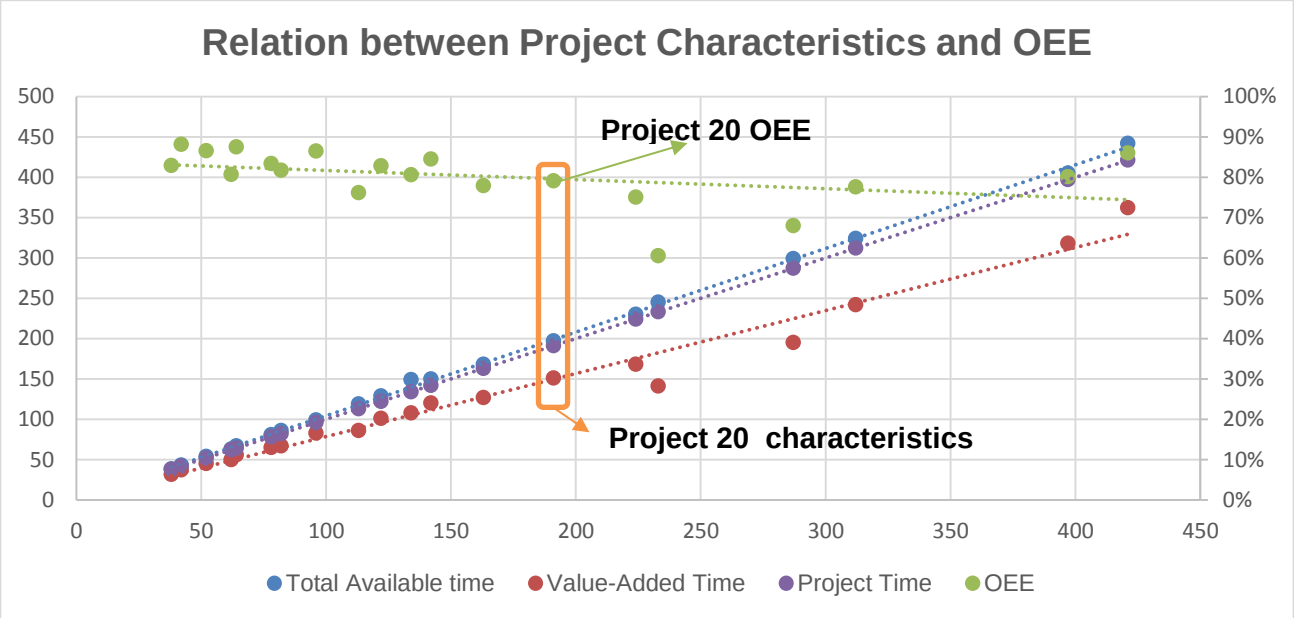


To summon, Exhibit 8 depicts a project, in which all waste types are defined. It is evident, that some waste types occur even before the project has started, which is shown in the gap between “Total Available Time” and “Project Time”. Also, the transparency of project efficiency calculation is seamless in representation of the gap between “Project Time” and “Value-Added Time”.

At the same time, the history of company’s project allows to develop understanding of possible control pitfalls depending on the size of the project. After cross-project calculation of OEE, I noticed that projects with average duration over 200 hours tend to be less effective than the small ones (Exhibit 9). Each project is represented by a set of four dots on a vertical line, the example of which is shown on project number 20. Apparently, the rising scale of project turns out to have a negative effect on project efficiency in the particular case of this company. By means of calculating average OEE across projects, a figure of 80% can be directly compared to world class figures, observed by Arcidiacono (2012), which is 85%. Therefore, hypotheses *H1.1* and *H1.2* are verified by the study. Regarding

the first hypothesis, project OEE ranges from 61% to 88% which denotes that at least 10% of project lead time can be shortened by careful waste elimination.

Exhibit 10. ***OEE across projects***



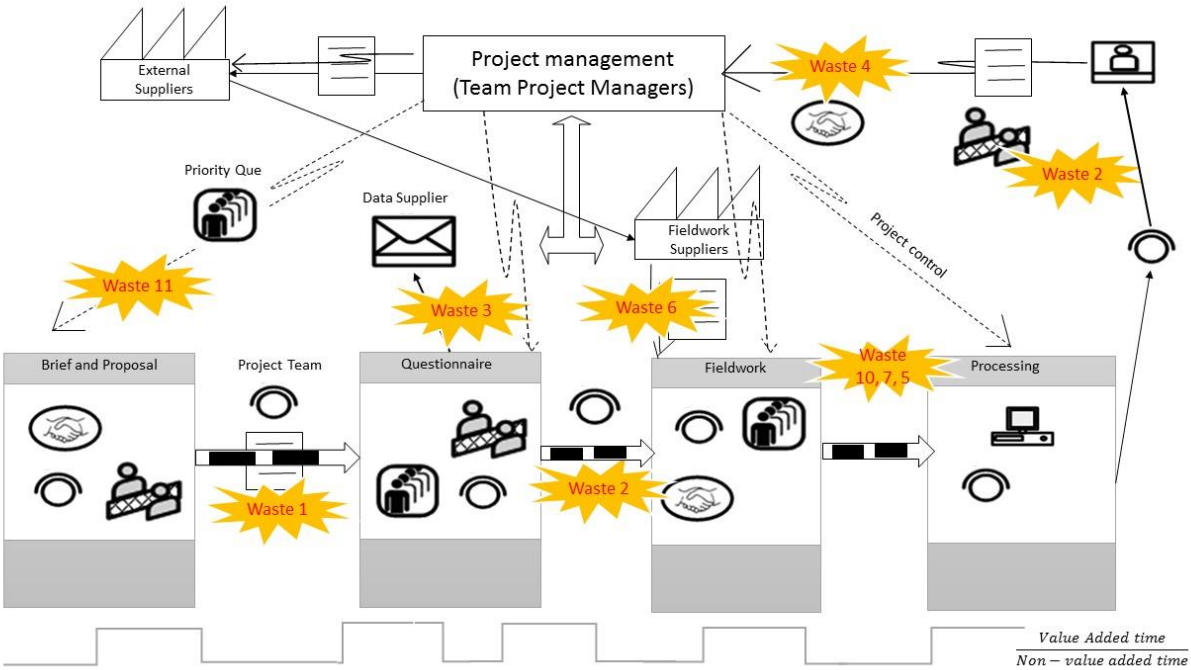
3.2.5. *Value Steam Map of company's processes*

During the last stage of data analysis, I depicted a simplified Value Stream Map (VSM) for the investigated market research PBO (Exhibit 10). Even though to read the diagram, the list of abbreviations (Exhibit 1, Appendix B) is required, the understanding of the key insights is easy to capture. It is the overview of interconnections between typical project processes and highlights of the key project areas at which key wastes occur.

Firstly, one of the lean-evident key defects of the system, for instance, is push-based transfer from one process to the next; on contrary, scholarly literature advocates the role of pull-based transitions for service sector (Ahlstrom, 2004). Second, project management department seem to be overloaded with current procedures of project control, since there are multiple points of client interaction and regulations; much of project

manager's workload comes from poorly standardized interaction between project team and support department and suppliers. This stands for higher proportion of micromanagement of processes, which leaves less time for process improvement, shortening of project lifecycle and, in effect, a number of projects processed in time period.

Exhibit 11. ***Value Stream Map for market research PBO***



Nevertheless, the devised approach including VSM shows positive results in terms of extending the role of project control and performance measurement by bringing in visual representation of processes and their efficiency. From researcher's viewpoint it is difficult to depict the characteristics of each process due to insufficient sample, sensitive data and lack of company-specific insights into project management. Additionally, company's projects range according to selected methodology, field, scale of representativeness and other market research parameters. The depicted map, though, shows a generalized view on the flow of value creation process,

operating with average OEE for available projects at 80% level. Thus, I consider the main hypothesis of the study to be valid.

3.3. Discussion of the results

The analytical materials, presented above, follow the devised methodological framework of the study (Section 3.1). The data gathered from primary and secondary sources verified all the hypotheses, which were set to test whether, in fact, there are measurable insights into project efficiency acquired from lean principles and tools.

Although the aforementioned company-specific set of wastes has been defined, systematized and used to interpret project non-value-added time, this paper does not build direct empirical connection of the proposed methodology with Earned Value data. At this stage, this was not accomplished due to a number of reasons, including competitor sensitive schedule and budget costs of analyzed projects, some of which were still ongoing. The unavailability of the data on client interaction also draws the line under interpretation of waste and/or value, because primary *"clients"* of the firm played secondary role in the study, while "the voice of the customer" was considered to be articulated by internal customers, namely project managers and coordinators, which had diverse project work experience.

One of the specific problems of attributing waste or value indicators in project activities consisted in active involvement of client representatives during the whole value creation process. In practice, although the theoretical foundation denotes that customer experience as well as value definition from external (primary) client is in priority (Frei, 2006), this study shows that clients do change their mind due to budget restrictions, scope redefinition, schedule adjustments and other circumstances, which significantly distorts project scope approved during initiation phase. While the contracting

company (PBO in question) continues to execute projects regardless of these changes, they actually produce more rework than internal communication and standardization problems of the company (see Exhibit 7). This may alter the way, in which value is defined in project-based settings (outside service companies with repetitive operations).

Overall, the selected lean principles and tools turned out to be closely connected to project control methodology both at conceptual and empirical levels. When a particular project is analyzed using Earned Value and a negative deviation is observed at specific time period, a defined set of wastes helps to classify all the activities occurring at specific date according to the standardized understanding of value (via Waste Log), gathered from internal clients of the company. With this tool at hand, the people as well as the reasons for deviations can be scrutinized, since a responsible person (for a particular activity) fills in a timesheet required for EV. As a result, less time is needed to actually control project execution and more time can be devoted to managing deviations as they occur.

At this point, the secondary aspects of lean (defined in section 2.1.1), namely decentralization and vertical information systems are beginning to make more sense in terms of their actual potential of reducing waste. For instance, decentralization may act like a waste and to be hidden in defined *underutilized employees*, which, combined with increased volume of *unclear communication* waste may demonstrate that management must be more centralized and coordinated. At the moment project employees seem to strive for tackling the problems themselves under supervision of project managers, however the resulting proportion of inefficiency calls for definite intervention from the management side.

The aspect of vertical IS, on the contrary, is conceptually more suitable for the chosen PBO as a solution point for *unclear communication*, *standardization*, *updating project materials and waiting* waste types. The

output of interviews, which contained questions regarding knowledge management in the organization revealed a lack of unity in knowledge codification, storage and distribution. The majority of projects were held in secure folders on shared intranet repositories, where no single system is utilized to make the knowledge generated within projects available and learnable.

4. Practical recommendations

Essentially, lean principles and handbooks denote that each waste type has specific ways of resolving; however, the definition of the custom cluster (low repetitiveness of operations) of service companies partially prevents a definitive set of solutions to be established across companies.

At the same time, there is another integral parameter, which can serve as an indicator for applicability of potential recommendations within the cluster: organizational maturity stage. Notably, according to OPM3, the last stage of maturity is continuous improvement held at the level of managing portfolio of projects (PMI, 2004), which sounds incredibly similar to the principle of kaizen, formulated and utilized by Japanese manufacturers decades before the establishment of Project Management Institute (PMI). Nevertheless, following this approach it becomes evident, that a set of recommendations can be highly applicable to PBO, which are at the level of measurement and standardization held at the level of projects and programs.

The recommendations formulated in this section stem directly from the results of the empirical study held in the chosen market research PBO. As noted in earlier chapters, the first milestone on the way to continuous improvement is standardization of input forms (4.1). Secondly, in order for standardization to be used, a pull-based mechanism of project analytics has to be established in the form of information system (IS), which would support a demand for project analytics in further organizational structure, enabling the feedback loop to project managers; I refer this aspect as knowledge-based control loop (4.2).

4.1 Standardization

The aspect of standardization plays the paramount role of reducing the risk of making a uniformed decision about project progress. As noted above, while EV methodology gives a numerical estimate for progress, however the

reasons behind any deviation have to be qualitatively investigated by project manager, which, in essence, is micromanagement. To avoid the need for micromanagement, a set of baseline causes for deviations must be somehow reflected and estimated in the form of, for instance, a timesheet, required of EV. Using the approach, developed in this paper, the essentiality of waste identification in timesheets becomes more and more obvious.

After the initial monitoring of waste types of the company has been completed, the information gathered on this stage serves as an input for defining, estimating and eliminating performance losses. However if the form of a timesheet is too complicated or requires too detailed information, no single employee of the firm is going to use it. That is why a template of information required for waste estimation is devised (Exhibit 12)

Exhibit 12. **Timesheet template**

Date	Project ID	Process type	Employee	N. of hours	Waste	Comment	Estimate
12.09.2014	76327	Brief & Proposal	784663	2	Waiting	XXX	10%
13.09.2014	32742	Link programming	876376	1	Rework	XXX	15%
14.09.2014	18937	Interview decoding	763874	3	Defects	XXX	20%

A standardized form, in which only basic parameters are included, becomes a powerful tool for decision-making. Column “Waste” contains waste type (or code), which serves as explanation for missing deadlines or budgeted costs, while column “Estimate” contains an approximate value in percentage of the operation completed. This timesheet template, in addition to information about milestone achievement, can as well serve as input for EV. Taking into consideration the resistance to complete reports daily, a standardized form like this enables to put less strain on employees by offering a single form to fill in the end of the day.

Another solution for initial estimation of waste can be transferred to IS, particularly by enabling intra-program analytics about duration of

activities and offering to select reasons for overdue. This approach might be more sensible also because a system can be programmed to allow timesheet submission only in case deviations are explained using standard waste log. However, conditions of timesheet usage can differ from company to company, and that is why both alternatives present an excellent opportunity to gather more project data. The use of the data gathered at this stage is presented in the next section.

4.2. Knowledge-based project control loop (KPCL)

As stated above, project control mechanisms are the main determinants of project performance in service industries (Upte and Goh, 2004), which is why the form of project control has to be (a) based on feedback from project managers and project team on the one hand and (b) aligned with the rest of firm's projects (as projects might compete for resources) on the other. While at the moment project control in the investigated PBO remained indisputably in the hands of project managers, the alignment of projects in a program or portfolio cannot be held by simple awareness of other managers' projects. This is why a control system to maintain both functions simultaneously is needed. The first step, however, is to establish a project management office (PMO) to actually use project data and inform alignment of projects, including process optimization.

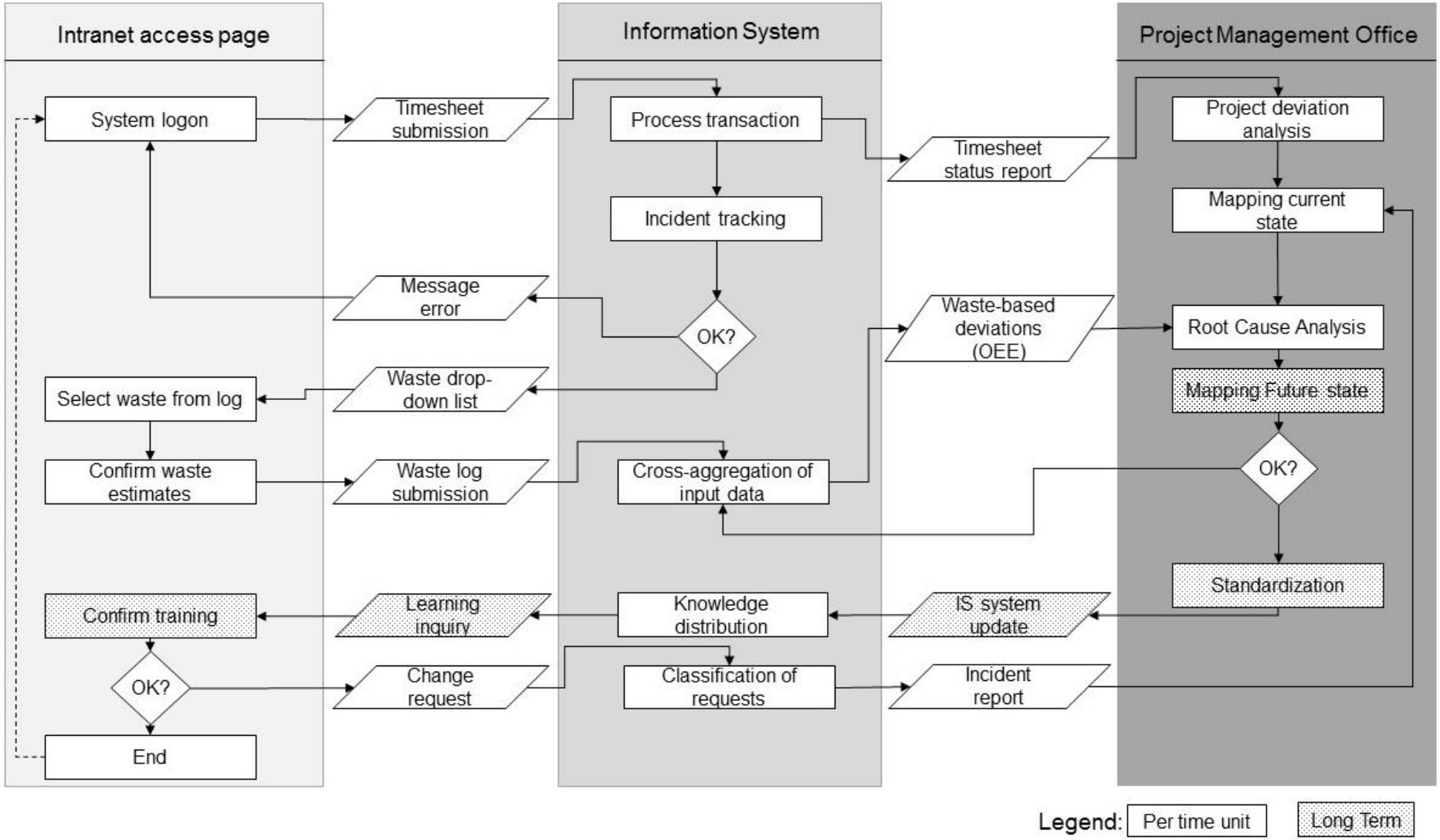
The scheme of proposed project control loop for assembling, analyzing and distributing knowledge about project bottlenecks is presented in Exhibit 13. The picture takes on view from three perspectives – employee intranet access, IS and PMO, because these are the main three forces of knowledge creation and distribution: project team is the source of data, IS is used to both clarify, pre-analyze and distribute ready-to-use solutions, while PMO acts like "knowledge broker", which makes a research, analyses and

makes decisions on whether a process (practice) can be optimized to increase project efficiency.

It is important to note, that Exhibit 13 shows both instant and long-term processes of knowledge usage to transform the way in which an organization operates. For instance, timesheet submission might be a daily or weekly procedure, while drawing current state map and future state map, as well as establishing which practice should be a standard, usually takes up the input of a number of projects, i.e. significant amount of time. The difference of time horizons, at the same time, should not be an excuse to discard the search for continuous improvement, which Exhibit 13 ultimately represents. Both theoretically and in practice, the knowledge accumulated and distributed among team, which takes on a typical project, helps to immensely reduce the activity of reinventing the wheel, i.e. waste time. The leading role of PMO can be drawn from the prognostic function (duration analysis using EV) and optimization (removing reasons behind waste activities), which is why establishment of PMO is highly desirable for the analyzed company.

At the moment, highly dispersed knowledge exists in the minds of project managers and teams, which remain rather stable across one or several industries. The unnoticed similarity of both waste and value across industries and firm's projects presents a potential for boosting firm's performance by first and foremost reducing project lead times, which, as shown in the study, can be achieved by defining and eliminating waste.

Exhibit 13. **Knowledge-based project control loop**



5. Conclusion

The current dissertation provides a number of insights into the field of project management, lean management and combination of the two with respect to project control and project performance measurement. First, the development of lean thinking has spread from manufacturing and service repetitive operations to project-based work, which builds a bridge for retranslation of lean principles in project control tools, which would structure project planning and execution, placing value (in both economic and project control meaning) front and center. The second insight builds on specific aspects of service industry and the need to follow the path of concept and practice localization. While the tools I used to demonstrate applicability did not undergo significant modifications, some characteristics of a service helped to shape the understanding of root causes of certain wastes. Thirdly, the understanding of the significance of project diagnostics, which form a transparent structure of value creation, provides a practice, which can be utilized in the management of project-driven organizations.

Due to unsurprisingly low availability of data, required to construct a precondition for lean project management, the necessary conceptual links between project and lean management exist in both literature and practical application. The justification of this thesis has led the study towards a conclusion, according to which project management has to take control of value creation chain. Although at the moment the requirements for transparency of value creation are confined to timesheets filling and Earned Value methodology in one case, or Key Performance Indicators (KPI) or Critical Success Factors (CSF) in other, the actual understanding of value differs across the three. The breakthrough idea of the dissertation is that the different understandings of value do not necessarily have to be converted in a single analytical unit; on the contrary, one method can cope with the drawbacks of the other.

One of the main findings related to the overload of project management department builds a link with the need for a more centralized, aggregate and knowledge-based means of communication, storage and distribution of project information. One of the outtakes related to vertical IS actually deals with this need, however in a too generalized way. More specifically, the main solution to corporate problems and leveraging the already existing knowledge in the company consists in aggressive knowledge management methods, which constitute a good practice in more advanced and knowledge-literate companies. The pool of such systems is often called Project Management Information Systems (PMIS). Although the positive links of these systems with increased user productivity as well as project success have already been discovered (Raymond & Bergeron, 2008), the current case study revealed the absence of such mechanism for, first of all, formulating the arguments for management decisions. The important prerequisite of data-based decision-making is simply disregarded; the knowledge generated within projects remains buried in the minds of project managers and abandons the flow of valuable information across the company. As noted before, this facilitates the need for more trainings, coaching and other knowledge sharing procedures, which, at the current company's lifecycle stage, remain unstandardized and/or outdated, pulling valuable human resources for project control.

The directions for further research stem from the main conceptual edges of the current study. For instance, the understanding of value, which differs from one methodology to another, is still uncertain regarding lean principles as applied in project-based companies. The availability of the necessary data, as well as client interaction, in my viewpoint, could form a framework of measuring value from actual understanding of what value is at particular project stages. This notion would also improve the methodology devised in this study: the understanding of value refines the understanding of

waste. Another significant direction is to more specifically define the algorithms of knowledge accumulation and sharing, project learning. This may refer to either building a Future State Map, or developing the internal principles or standards of project work or devising templates for more lean friendly data access points, which would reflect company's regulations on knowledge management procedures. Overall, a study, which would test the applicability of the devised EV extension on quantitative industry-wide data, is highly desirable due to its fresh and independent view on the current project management practice.

6. Critical reflections

This study is notable for me in two respects. First, this is a conscious attempt to develop a methodology, which is commonly used and widely known. This sets a particular challenge in terms of conceptual linkage, easiness of practical application and critical reflections of the main stakeholders, involved in this processes. Second, although this is a desk-based research, a defined and detailed project plan prevented or alleviated a number of risks, connected to stakeholder environment of the project, schedule deviations and project control mechanisms. For instance, when risk mitigation was developed for an unfavorable outcome of negotiations with initially selected market research PBO management, I already developed the possible options of resolving the problem of unavailable data. In this regard, I mastered the combination of both development and support of project documentation, required of a good project management practice.

This study has also formed a springboard for a future career of optimization of project management procedures in Russian and European counties, which lack the systematic and value driven approach for performance measurement and project control. The critical incident of articulation, search, justification and application of a never defined or conceptually established method increased my personal awareness of tools and methodologies, which can form a basis for actual performance improvement, versus purely theoretical claims. My dissertation establishes a means to insightfully manage schedule deviations, providing crucial understanding of the hidden causes.

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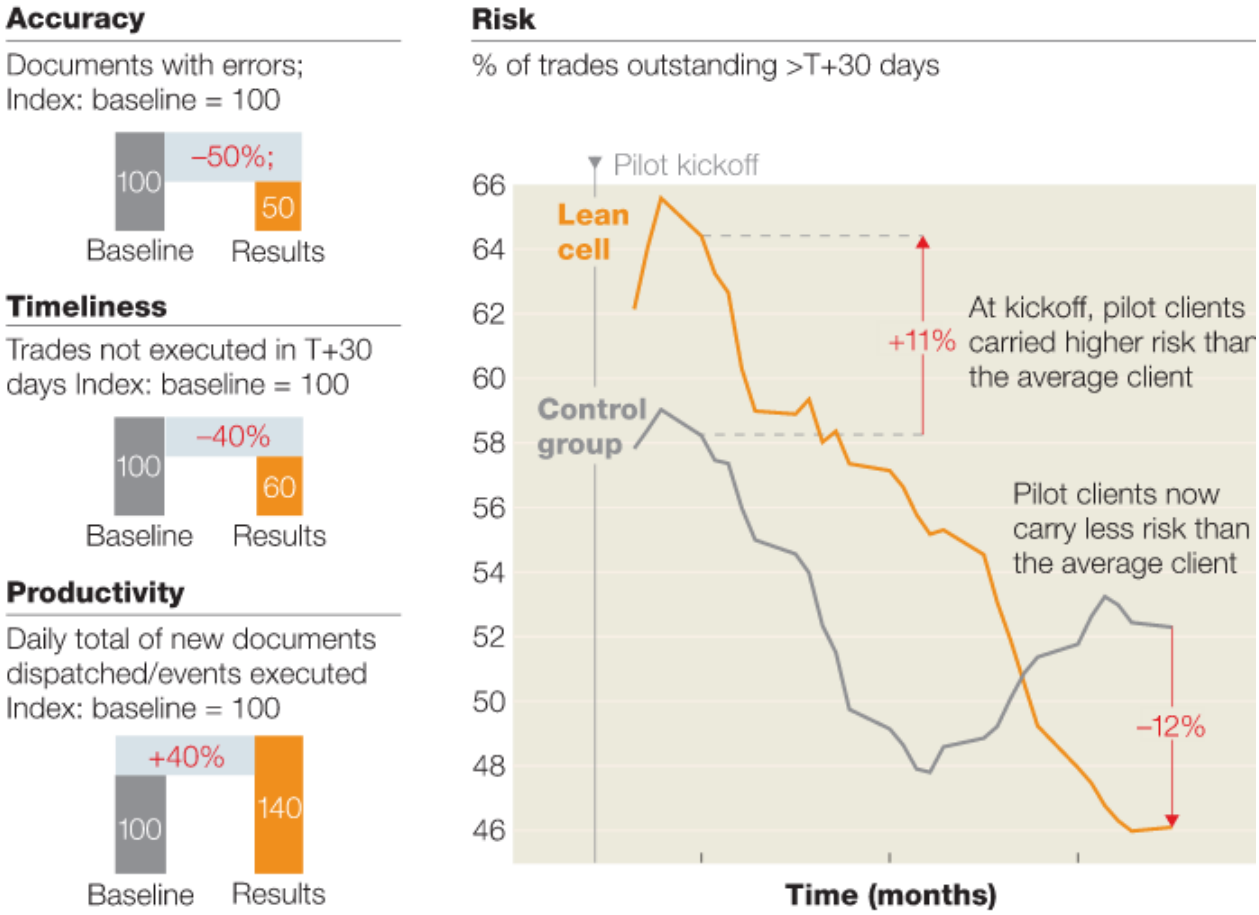
Appendix A

Exhibit 1. McKinsey & Company case study of Lean in global investment bank



Source: Coxon, M. et al. (2011) Using lean in wholesale financial services, McKinsey Quarterly,

Table 1. Lean Principles (based on Andersson et al., 2006)

Principle	Description
(1) Understanding customer value	This means that only the requirements of customers, either internal or external are important. In project management literature the "customers" are the main stakeholders of the project, who always define the value of each product in their own terms. The role of a project manager at this point is to synthesize the concept of value, which is maximal to satisfy each stakeholder's need;
(2) Value stream analysis	This principle facilitates the need to walk all the way through value creation processes: process-by-process and even further – down to activity level. If the process is regarded as value-added, there is still a need to analyze activities and see whether all of them are indispensable for the next project stakeholder. The non-valued-added activities and processes have to be eliminated from the structure of business unit functioning;
(3) Flow	Having taken a snapshot of the current state and eliminated the unnecessary elements, it is important to take a step further and cater for the coherency and seamless connections between processes and activities, so that the continuous flow of value creation processes proliferates from supply chain through the production and further to product distribution. In classic project management a risk plan plays a role of identification of potential wastes and gaps between activities or processes;
(4) Pull	Pull as transfer to low-buffer system of activity-based scheduling, which similarly to theory of constrains (TOC), introduced by Goldratt (2003), is based on the staged release of system bottlenecks and extension of this approach throughout the value chain. In essence, an activity should only be performed at pace, at which the output of this activity is required downstream (Andersson et al., 2006), which prevents stock and waiting time for the whole chain;
(5) Perfection	This principle reflects the philosophical aspect of lean, called "kaizen", continuous improvement, which outlines the importance of constant efforts aimed at reducing waste. In project management, this refers more to knowledge base maintenance and constant pull of knowledge, generated by ongoing projects, and further distribution to future project entities, which would reduce waste of reinventing the wheel.

Exhibit 2. Lean methodologies and tools (Broughton, 2012)

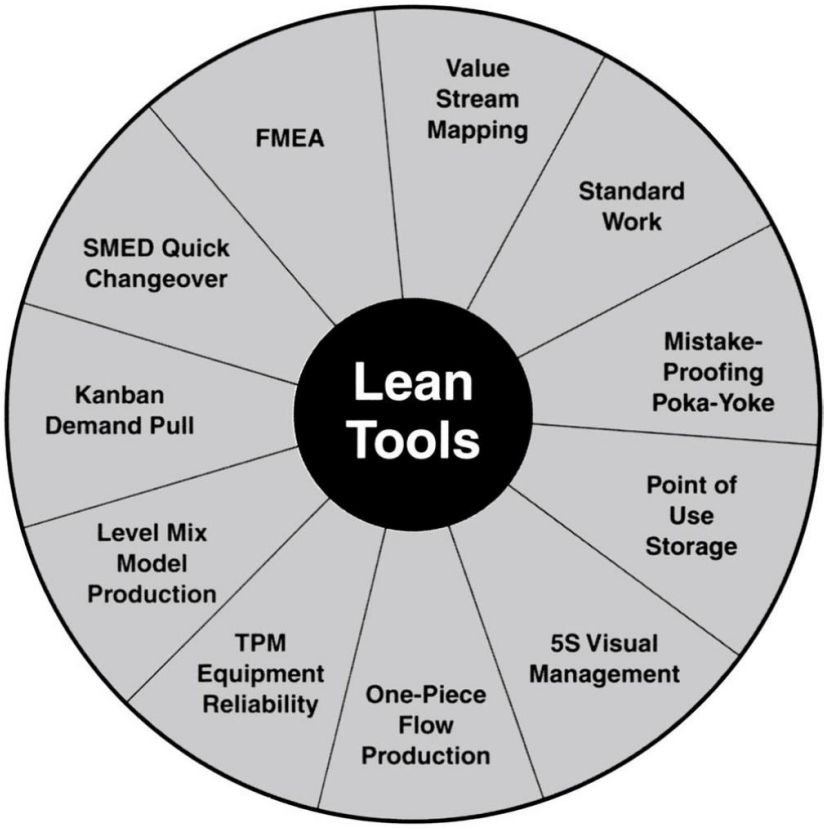


Table 2. Description of original lean tools

Tool	Description
Value stream analysis	VSM is a lean tool that identifies the flows of information and materials, thereby helping practitioners to concentrate on the principle of flow instead of particular wastes in the system (Yu et al., 2009). After the idea of value-added and non-value-added activities is obtained (Hines & Rich, 1997), the first step is to depict a current state map (CSM), which describes the processes as they now occur (Tapping et. Al., 2002). In production line shop floor, it is invaluable to use stopwatch to record actual times for each process to obtain reliable data (Rother and Shook, 2003), however in either classic project management settings (i.e. construction) or service industries management where projects are highly customized, walking the whole way through the value stream is hardly possible. Instead, in likewise cases Yu et al. (2009) suggests to use an intranet tracking system distribute the role of data collection among project executers, in which the data inputs are quite similar to earned value methodology: "the booking date, confirmed start date, actual start date, and actual finish date of every task" (Yu et al., 2009: 783). After the CSM is analyzed and wastes are eliminated, a future state map (FSM) has to demonstrate the improved structure of processes with corresponding timing (Tapping et al., 2002).

Poka-Yoka	Another tool, which is very close to standardized work, is error proofing. It refers to the introduction of visual control mechanisms, which embed safety and functionality (Shingo & Dillon, 1986) (in manufacturing settings), for instance, by changing the form of a socket, which physically does not engage if applied upside down
TPM and Equipment reliability	Using description provided by Kilpatrick (2003), Total Productive Maintenance (TPM) utilizes methods of equipment maintenance and "calls upon the knowledge and cooperation of operators, equipment vendors, engineering, and support personnel to optimize plant performance" (Damrath, 2012: 19). The main goal of this tool is to increase the lifecycle of equipment usage, therefore decreasing downtime, breakages, stops, etc. The OEE is an approach adopted from lean management and it represents a powerful method to monitor and improve the efficiency of manufacturing and transactional processes, and is frequently used as key metric in Total Productive Maintenance (TPM) and Lean programs. One of the main goals is to reduce the "Six big losses", clustered in three categories: Downtime, Speed and Quality losses (Arcidiacono et al, 2012). This is a significant tool for project management, as the metrics for equipment can be emulated for human operators, as the numerical estimation for task completion is mainly given in time equivalent. In manufacturing environment the calculation of OEE has already become both standard and additional business solution, offered by giants of assembly lines such as Siemens (2014), which has devised automatic calculation software. The logic of OEE calculation is presented in Exhibit 3 (Appendix).
Other lean tools	Manufacturing settings, however have a range of other highly applied tools, one of which is Single Minute Exchange of Dimes (SMED), which stands for reduction of setup time (below 10 minutes), when multiple types of units are manufactured using the same equipment, which allows to achieve lower unit costs and decrease the amount of stock (McIntosh et al., 2000). Another tool closely related to maintenance is 5S, which represents a guideline of visual control of workplace and operations optimization (i.e. sorted tools, standard movements, etc.). There is also a Failure Mode and Effects Analysis (FMEA), which is used to "prioritize potential defects based on their severity, expected frequency, and probability of detection" (Damrath, 2012: 20). These and other tools are highly applicable to highly repetitive and standardized production process, however their adjustment to project management is highly challenging due to the aforementioned non-repetitive essence of activities in most projects.

Exhibit 3. Calculation of OEE

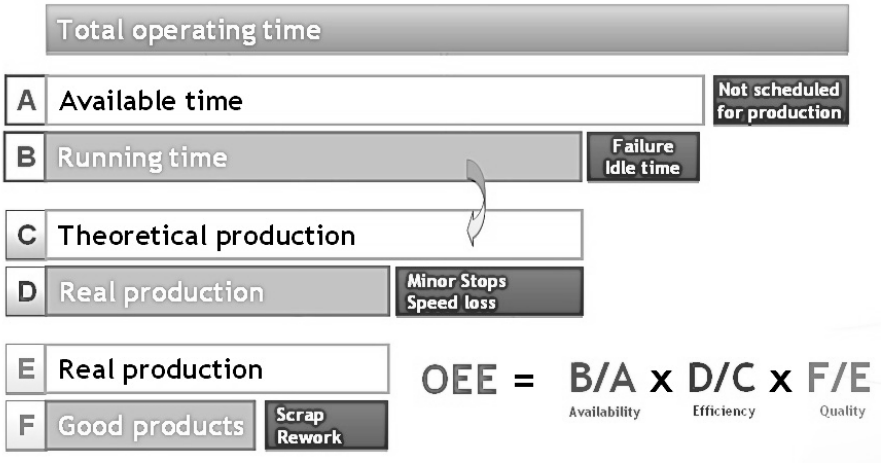


Exhibit 4. Categorization of literature related to application of lean principles (Suarez-Barraza et al., 2012)

Category	Major references reviewed
Category 1. Exploration of Lean Service (reflections and foundations)	
1	Skinner (1969), Levitt (1972), Levitt (1976), Lawler (1978)
Category 2. Creation of the theoretical framework of Lean Service	
2a (1980–1989)	Chase and Garvin (1989), Parasuraman et al. (1988), Schmenner (1986)
2b (1990–1999)	Armistead (1990), Bowen and Lawler (1992), Chase, Kumar, and Youngdhal (1992), Fitzsimmons and Fitzsimmons (1994), Gallouj and Weinstein (1997), Ghobadian, Speller, and Jones (1994), Harvey (1998), Heskett, Sasser, and Hart (1990), Reichheld and Sasser (1990), Schlesinger and Heskett (1991), Womack and Jones (1996)
2c (2000–2008)	Abdi et al. (2006), Allway and Cobertt (2002), Dahlgaard and Dahlgaard-Park (2006), Grönroos (2000), Hing Yee Tsang and Antony (2001), Karmarkar (2004), Kumar et al. (2008), Lovelock and Wright (2001), Prajogo (2006), Swank (2003), Weekkody, Currie, and Ekanayake (2003)
Category 3. Specific applications of Lean Service	
3a (Health care)	Aherne (2007), Ben-Tovim et al. (2007), Collins and Muthusamy (2007), Dahlgaard et al. 2011, Fillingham (2007), Jones and Mitchell (2006), Kollberg et al. (2007), Komashie, Mousavi, and Gore (2007), Lipley (2008), Martin (2007), Massey and William (2005), Spear (2005), Sprigg and Jackson (2006), Togal-Taner, Sezen, and Antony (2007)
3b (Education)	Andersen Rostgaard (1995), Hines and Lethbridge (2008), Bergman (1995), Comm and Mathaisel (2005), Emiliani (2004), Emiliani (2005), Dahlgaard et al. (1995), Dahlgaard and Ostergaard 2000, Kells (1995), Logothetis (1995), Spanbauer (1995), Tofte (1995), Van Der Wiele (1995), Van Zadelhoff, De Wet, Pothas, and Petrorius (1995)
3c (Banking and finance)	Bátiz-Lazo and Wood (1999), Cocheo (1995), George (2003), Streeter (1990)
3d (Airlines)	Greenwood et al. (2002), Hutchins (2006), Newton (2007), Reinhardt (2007)
3e (Hotels and restaurants)	Heskett (1987), Berger et al. (1989), Johnson and Martin (1993), Suárez-Barraza (2008)
Category 4. New trends and extensions of Lean Service	
4a (Lean-Kaizen Public Service)	Bhatia and Drew (2006), Krings, Levine, and Wall (2006), Furterer and Elshennawy (2005), Radnor and Boaden (2008), Suárez-Barraza and Ramis-Pujol (2008), Suárez-Barraza et al. (2009)
4b (e-service)	Voss (2003)
4c (Service excellence – total quality service, service science)	Gupta et al. (2005), Sureshchandar et al. (2001), Den Hartog and Verburg (2002), Johnston (2004)

Table 3. Characteristics of service industry clusters (Bicheno, 2004)

Cluster name	Description
4) *Idealized type*	This type of services stands for a restructuring of a system, for instance in education, government, public safety, etc. The repeatability of such projects is low due to the volume and scale of work to be done. Customer involvement is usually high in the planning phase, where customer requirements have to define the new system; however, the next contact occurs only when the project is finished and the service is handed to the client. .
5) *Custom type*	Custom type of services is characterized by significant role of facilities: resources, tools, datasets, etc. of service provider, which are utilized to solve customer's problem. Although the solution to the problem is easy to articulate, the way to actually solve the problem is not. This is why higher customer interaction is needed to define and redefine the provider's approach to problem solving. Some classic examples of this category are management consulting, legal services, market research and analytics, branding, advertising, IT platform development, etc. The majority of such companies are project-based organizations (PBO).
6) *Transaction type*	This category is characterized by high similarity with manufacturing process, as it requires highly repeatable, standardized operations to be optimized, while customer inputs (requirements) are classified into standard groups. Examples of this category may include fast food, banking, insurance, call centers, retail, etc.
7) *Interactive type*	Interactive type is based on the history of interaction between customers and service providers. Generally, this category is characterized by high competition among companies and customer experience is as important as the service itself. Even though initial set of customer requests is defined and optimized, there are numerous factors that contribute to more personal and deviant requests, which are also considered to be important part of service provision. Some examples include airline companies, hotels, healthcare and restaurants.

Table 4. IHIP framework (Bortolotti & Romano, 2012)

Principle	Description
Intangibility (I)	Promised performance (Moeller, 2010);
Heterogeneity (H)	Refers to increased presence of human factor in service quality, which differs from one operator to another. It also highlights that service standardization is only possible to some extent (Damrath, 2012)
Inseparability (I)	Services are consumed as they are being produced, simultaneously
Perishability (P)	Inability to store a ready service
Common Characteristics (Ahlstrom, 2004)	- Customers are the central part of orientation in many service industries; - The customer evaluates both the output of value creation process and the experience (Johnston and Clark, 2001). This point is extremely relevant for many service PBO, be because customer interaction and negotiations, which may distort the working order and be seen as waste, may actually add value to their experience. - The classic waste type, inventory, is not a problem for service sector, since a pure service cannot be physically stored. This highlights that in service value stream each activity always has to be pulled.

Table 5. Ten wastes of service industry (Bonaccorsi et al., 2011)

Defects	Data entry errors; Lost files; Lost or damages goods;
Duplication	Data re-entering; Multiple signatures; Unnecessary reporting; Multiple queries;
Incorrect Inventory	Stock out; Wasting time finding what was needed; Unnecessary copies;
Lack of customer's focus	Unfriendliness; Rudeness; Poor attention to the customer;
Overproduction	Reports no ones will ever read; Processing paperwork before time;
Unclear communication	Incorrect information; Lack of standard data format; Unclear work flow;
Motion/Transportation	Poor layout; Ineffective filing; Poor ergonomic;
Underutilized Employees	Inadequate tools; Excessive bureaucracy; Limited authority;
Variation	Lack of procedures; Lack of standard formats; Standard time not defined;
Waiting/Delay	Waiting for approvals; Downtime; Waiting for supplies;

Exhibit 5. Value Stream Map (Rother and Shook, 1999)

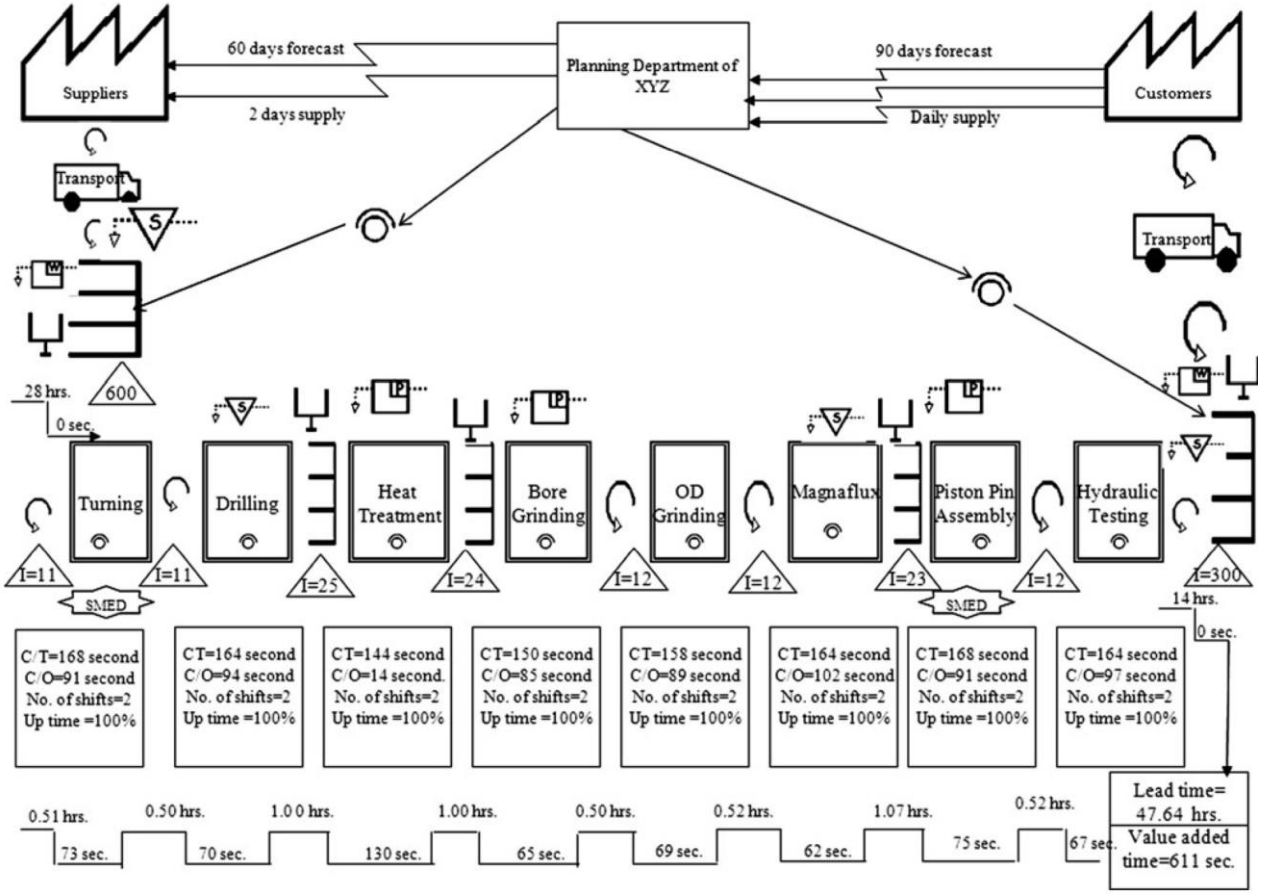
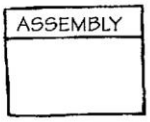
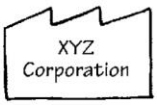
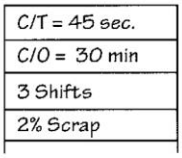
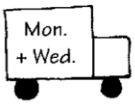
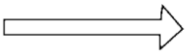
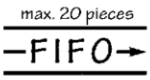


Exhibit 6. Abbreviations for Value Stream Map (Rother and Shook, 1999)

The icons and symbols for current- and future-state mapping fall into three categories: Material Flow; Information Flow; and General Icons.

Material Icons	Represents	Notes
	Manufacturing Process	One process box equals an area of flow. All processes should be labeled. Also used for departments, such as Production Control.
	Outside Sources	Used to show customers, suppliers, and outside manufacturing processes.
	Data Box	Used to record information concerning a manufacturing process, department, customer, etc.
	Inventory	Count and time should be noted.
	Truck Shipment	Note frequency of shipments.
	Movement of production material by PUSH	Material that is produced and moved forward before the next process needs it; usually based on a schedule.
	Movement of finished goods to the customer	
	Supermarket	A controlled inventory of parts that is used to schedule production at an upstream process.
	Withdrawal	Pull of materials, usually from a supermarket.
	Transfer of controlled quantities of material between processes in a "First-In-First-Out" sequence.	Indicates a device to limit quantity and ensure FIFO flow of material between processes. Maximum quantity should be indicated.

	Sequence-Pull Ball	Gives instructions to immediately produce a predetermined type and quantity, typically one unit. A pull system for subassembly processes without using a supermarket.
	Kanban Post	Place where kanban are collected and held for conveyance.
	Kanban Arriving in Batches	
OXOX	Load Leveling	Tool to intercept batches of kanban and level the volume and mix of them over a period of time.
	"Go See" Production Scheduling	Adjusting schedules based on checking inventory levels.

General Icons	Represents	Notes
weld changeover / welder uptime	"Kaizen Lightening Burst"	Highlights improvement needs at specific processes that are critical to achieving the value stream vision. Can be used to plan kaizen workshops.
	Buffer or Safety Stock	"Buffer" or "Safety Stock" must be noted.
	Operator	Represents a person viewed from above.

Information Icons	Represents	Notes
	Manual Information Flow	For example: production schedule or shipping schedule
	Electronic Information flow	For example via electronic data interchange.
Weekly Schedule	Information	Describes an information flow.
20	Production Kanban (dotted line indicates kanban flow)	The "one-per-container" kanban. Card or device that tells a process how many of what can be produced and gives permission to do so.
	Withdrawal Kanban	Card or device that instructs the material handler to get and transfer parts (i.e. from a supermarket to the consuming process).
	Signal Kanban	The "one-per-batch" kanban. Signals when a reorder point is reached and another batch needs to be produced. Used where supplying process must produce in batches because changeovers are required.

Appendix B

PART 1 ***Interview Guide***

Applied Project Management Research Project

Part 1. Organizational context.

1. Grand-tour question. What is your current/previous position in the company? Could you please describe your main responsibilities?
2. How is the work in the company generally organized? Who operates task delegation? ***If "project" was mentioned*** -> What is your role in the project work?

   Could you please reflect on how project work is organized (with what tools, methods, software, etc.)?

Part 2. Project management of the company.

1. Grand-tour question. What do you think about project management of the company? What aims and goals does it *effectively* solve? (***Clarify the meaning of effectiveness if needed***)
2. Do you participate in management activities (monitoring, optimization, etc.)? Please, describe in which way.
3. How would you reflect on the relation of company's project management to project success?

Part 3. **Process efficiency and waste types.**

1. Grand-tour question. Could you please tell me about the main processes, in which you are employed?

   After the answer show the supplementary questionnaire with the list of processes to select from

   Can you call them "efficient"? Why/Why not?
2. What types of performance losses (wastes) specific to each process can you think of? How often do they occur? Are these impossible to get rid of?

   After the answer show the supplementary questionnaire with the list of common waste types to select from
3. What types of business activities (the ones that do not add value immediately, however are important for business functioning)?

Part 4. Project and organizational learning.

1. Grand-tour question. Is there any mechanism of knowledge codification and distribution? What is it? Are there any case studies and examples of past work to refer to?

   Who is responsible for accumulation of project knowledge?

   If "knowledge codification" was mentioned Would you characterize this process/mechanism as effective?

Part 5. Biographical questions.

1. Gender
2. Age
3. Marital status
4. Highest education level achieved

a. Specialization (if exists)

PART 2 ***Supplementary materials for interview guide***

Introduction

This questionnaire is a part of a graduation project for the study of application of lean in principles in project management methodology.

All the questions presented relate to your experience of working on the projects of the company related to market research and consumer preferences.

We kindly ask you to answer much as possible honestly. Completing the survey will take **no more than 5 minutes.**

All the information will be used in a generalized form.

D1. What is your gender?

ONE ANSWER

Male	
Female	

D2. What is your age?

PLEASE FILL IN YOUR AGE BELOW

_____ years old

S1. What processes are/were you employed at?

MULTIPLE ANSWERS

For online research designs		For non-online research designs	
Negotiation of Project Brief	1	Division of purchasing list	11
Division of Research Proposal	2	Purchasing of test goods/materials	12
Division of Questionnaire	3	Goods marking, audit	13
Questionnaire approval	4	Product sending to regions	14
Programming of the questionnaire	5	Start of the fieldwork	15
Questionnaire link check and proof reading	6	Search for template for toplines (data representation) and report	16
Link approval	7	Outline proposal for data analysis	17
Other	98	Preliminary research report	18

For online research designs		For non-online research designs	
		Final project report	19

IF THE CODE 98 IS CHOSEN -> CLARIFY

A1. There are the categories of major waste types found in literature regarding waste types. Please read each category and following examples and select the wastes you have faced in practice accordingly.

ONE ANSWER FOR EACH CATEGORY

1	DEFECTS	Data entry errors; Lost files; Lost or damages goods;
2	DUPLICATION	Data re-entering; Multiple signatures; Unnecessary reporting; Multiple queries
3	INCORRECT INVENTORY	Stock out; Wasting time finding what was needed; Unnecessary copies NOTHING
4	LACK OF CUSTOMER'S FOCUS	Unfriendliness; Rudeness; Poor attention to the customer
5	OVERPRODUCTION	Reports no ones will ever read; Processing paperwork before time;
6	UNCLEAR COMMUNICATION	Incorrect information; Lack of standard data format; Unclear work flow;
7	MOTION/TRANSPORTATION	Poor layout; Ineffective filing; Poor ergonomic
8	UNDERUTILIZATION OF KNOWLEDGE	Inadequate tools; Excessive bureaucracy; Limited authority;
9	VARIATION	Lack of procedures; Lack of standard formats; Standard time not defined
10	WAITING/DELAY	Waiting for approvals; Downtime; Waiting for supplies;

Table 1. Codes of waste types in the study

Id	Waste type
1	Defects
2	Duplication/Rework
3	Overproduction
4	Lack of focus
5	Unclear communication
6	Motion
7	Underutilized Employees
9	Variation
10	Waiting
11	Lack of standardization
12	Outdated materials

Table 2. Common waste types (interview material)

Common waste types across organization					
id	**Description**	**id**	**Description**	**id**	**Description**
4	Lack of client's focus: rework connected poor client awareness of connection between request change and schedule, cost and quality of the project	5	Unclear communication: Lack of coaching for common projects and requests, connected to them	2	Duplication: Lack of standardized trainings about use of technocal equipment and software
6	Motion: Control and monitoring of fieldwork personnel, undefined authority	9	Variation: Project reports using client formatting	1	Defects: data entry errors
12	Updating report templates: standardization of visual output	11	Standardizing request forms (data processing, purchase outline, etc.)	11	Creation of corporate libraries: picture, logos, methods, etc.
11	Developing macros	12	Updating descriptions of project methodology		

Waste

Business Activity

Table 3. Process-dependent waste types

			Process-dependent wastes						
id	**Project brief and proposal**	**id**	**Questionnaire**	**id**	**Link programming**	**id**	**Fieldwork**	**id**	**Processing**
2	Duplication: Re-identification of client needs due too poor formulation at the first stage	5	Unclear communication: Questionnaire rework connected to change of client of request	2	Rework connected to errors of operators	6	Motion: marking and calculating product supply without technical tools	2	Rework related to poor communication
4	Lack of customer focus: Time-consuming negotiations on client brief	7	Underutilized employees: Questionnaire rework connected to unsupervised initial creation	2	Rework connected to lag of client feedback loop: no correction until this stage, which puts additional strain on project schedule	2	Rework of errors on previous stages	10	Unstandardized request forms for data analysis - waiting time and rework
2	Rework for proposal due to hidden budget restrictions unstated by the client at initial meetings	3	Overproduction: creating too detailed instructions for link programming	6	Motion: Visual corrections, related to variation in questionnaire aim, method: screen separation, text layout, picture editing. Related to unstandardized questionnaire and variation at request level	1	Defects: Additional interviewing due to malfunctioning of technical equipment or poor measurement	7	Underutilized employees: data processing request, which can be performed by employees themselves
9	Variation: Unstandardized price list, requiring waiting time for additional approval	2	Rework connected to client unregulated requests: format rework, interview length, etc. Internal variation on client's side			10	Waiting: lag in start of fieldwork related to errors of subcontractors	2	

10	Waiting: Time-consuming regulation and information requests due to lack of IS that combines information on ongoing projects: PM name, Schedule, Risks, etc.		10	Incorrect inventory: time lag required to revise and prepare questionnaire on sub-contractor's side	Duplication of work related to client inquiries, which are unrelated to data quality or representation
9	Variation: No standardized library for brand picture and logos necessary for proposal design		10	Delay in the start of fieldwork due to waiting for approval from field shops. Poor supply management and regulatory gaps.	
6	Motion: Paper work related to client documentation and confirmation. This is a supplementary function unrelated to creation of project proposal		10	Time lag needed to gather additional interviews connected to client request (no extra capacity)	

Waste
Business Activity

Table 4. Secondary data analysis output (Number of Hours)

Project ID	*Other*	*Brief and Proposal*	*Questionnaire*	*Link Programming/ Fieldwork*	*Processing*	*Project Time*	*Total Available time*	*Value-Added Time*	*OEE*
4	1	1	1	1	1	42	43	37	88%
12	3	1	2	1	1	64	67	56	88%
16	2	1	2	1	1	52	54	45	87%
10	3	4	3	1	2	96	99	83	86%
9	21	12	10	12	4	421	442	362	86%
11	8	9	2	1	2	142	150	120	85%
15	3	4	1	3	2	78	81	65	83%
7	0,5	2	1	2	1	38	38,5	31,5	83%
8	7	7	2	2	3	122	129	101	83%
17	4	4	2	3	2	82	86	67	82%
3	1	1	4	2	4	62	63	50	81%
19	15	2	3	4	2	134	149	108	81%
2	8	22	18	21	10	397	405	318	80%
20	6	16	4	11	3	191	197	151	79%
6	5	7	4	3	17	163	168	127	78%
13	12	10	21	13	14	312	324	242	78%
1	6	5	8	4	4	113	119	86	76%
5	6	4	2	32	12	224	230	168	75%
18	12	23	4	21	32	287	299	195	68%
14	12	33	31	12	4	233	245	141	61%
Total number of hours	**135,5**	**168**	**125**	**150**	**121**		**Average OEE**		80%

Exhibit 1. List of abbreviations for Value Stream Map (Bonaccorsi et al., 2011)