PERFORMANCE MEASURING AND MANAGEMENT IN PHARMACEUTICAL INDUSTRY

Lappeenranta–Lahti University of Technology LUT

Master's program in Industrial Engineering and Management, Master's thesis

2023

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Examiners: Professor Hannu Rantanen

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ABSTRACT

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Industrial Engineering and Management

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Performance measuring and management in pharmaceutical industry

Master’s thesis

2023

62 pages, 12 figures, 3 tables and 1 appendix

Examiners: Professor Hannu Rantanen

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Keywords: Performance measuring, performance management, KPI, business intelligence, Power BI, pharmaceutical industry

Objective of this research is to develop performance measures and management in pharmaceutical industry. In an era of digitalisation, more data is becoming available for businesses to utilize. Analytics and Business Intelligence (BI) are introducing new technologies and tools for the better performance measures and management. Accurate data integrated metric improves organizational performance jointly with people and technology. Key Performance Indicators (KPIs) should be used against proper objectives, and built with standard process that includes documentation and validation. User should know the KPI data source and formula to understand the progress and changes in KPI results.

Interviews of eleven managers from the case company revealed that more unified and centralized approach in KPI and reporting should be implemented. This included objectives, KPIs and metrics would serve the organization and ownership of them is divided to cluster of teams. More KPIs should be added according to the needs and requirements of departments, and current ones improved. Many interviewees were using automated reports that improved data quality and guidance in decision making. Possibility of higher visibility regarding to viewing progress of other areas was received positive. Based on interviews and literature findings a KPI and reporting framework suggestion for the case company was made. Framework consisted of five modules: info screens, quality metrics, department KPIs, business unit dashboards, and organizational KPIs. Implementation of the framework would happen via BI system and Power BI tool which includes data flows, analyse, and visualisation in reports and dashboards.

TIIVISTELMÄ

Lappeenrannan–Lahden teknillinen yliopisto LUT

LUTin insinööritieteiden tiedekunta

Tuotantotalous

Arkko Ketolainen

Suorituskyvyn mittaaminen ja johtaminen lääketeollisuudessa

Tuotantotalouden diplomityö

2023

62 sivua, 12 kuvaa, 3 taulukkoa ja 1 liite

Tarkastajat: Professori Hannu Rantanen

Apulaisprofessori Minna Saunila

Avainsanat: Suorituskyvyn mittaaminen, suorituskyvyn hallinta, KPI, liiketoimintatiedon hallinta, Power BI, lääketeollisuus

Tämän tutkimuksen tavoitteena on kehittää suorituskyvyn mittareita ja –johtamista lääketeollisuuden saralla. Digitalisaatio on tuonut yrityksille yhä enemmän tietoa hyödynnettäväksi. Analytiikka ja liiketoimintatiedon hallinta auttavat uusien tekniikoiden ja työkalujen soveltamista suorituskyvyn mittaamisessa ja –johtamisessa. Tarkat dataan perustuvat mittarit kehittävät organisaation suorituskykyä yhdessä ihmisten ja teknologian kanssa. Keskeisiä suorituskykyindikaattoreita tulisi käyttää tavoitteita vastaan, ja ne tulisi rakentaa käyttäen yhdenmukaista prosessia. Käyttäjän olisi tunnettava mittarin tietolähde ja kaava, jotta hän ymmärtäisi paremmin indikaattorin edistymisen ja muutokset.

Case yrityksen yhdentoista managerin haastatteluissa kävi ilmi, että yhtenäisempi ja keskitetympi lähestymistapa mittatereiden ja raportoinnin kannalta olisi suotavaa. Tämä sisälsi tavoitteet ja suorituskykymittarit, jotka palvelisivat organisaatiota ja joiden omistajuus jaettaisiin tiimiryhmille. Osastojen tarpeiden ja edellytysten mukaan olisi lisättävä suorituskykyindikaattoreita ja parannettava nykyisiä. Monet haastatelluista käyttivät automatisoituja raportteja, jotka paransivat datan laatua ja päätöksenteon ohjausta. Myös mahdollisuus saada parempi näkyvyys muiden osastojen edistymisen tarkasteluun sai myönteisen vastaanoton. Haastattelujen ja kirjallisuuden perusteella yritykselle laadittiin ehdotus suorituskykymittariston ja raportoinnin viitekehyksestä. Viitekehys koostui viidestä moduulista: infonäytöt, laatumittarit, osastojen KPI:t, yksiköiden näkymät, ja organisaation KPI:t. Kehyksen implementointi tapahtuisi BI-järjestelmän ja Power BI -työkalun avulla, jotka sisältävät datan virtauksen, tiedon analysoinnin, ja raporttien ja näkymien visualisoinnin.

ACKNOWLEDGEMENTS

I want to thank company who made it possible for writing this master's thesis for them. This appreciation includes the people involved guidance during the process of completing the thesis from company side. I want to acknowledge examiner for university side for assisting in the thesis work. Also special thanks to my girlfriend and family who has been supporting and sparring me during the six month thesis project.

Completion of this work will conclude my five-year studies in LUT-University. The journey has given new friends and experiences which I am grateful of. Hopefully we will stay in contact in future whatever it brings.

Lappeenranta, 19.9.2023

Arkko Ketolainen

ABBREVIATIONS

AI	Artificial Intelligence
BI	Business Intelligence
CAPA	Corrective and preventive action
CC	Change Control
CRM	Customer Relationship Management
DAX	Data Analysis Expression
DDDM	Data driven decision making
ERP	Enterprise Resource Planning
KPI	Key Performance Indicator
OLAP	Online Analytical Processing
SQL	Structured Query Language

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1 Introduction

Digitalization and Industry 4.0 are offering new technologies across different industrial fields. Latter’s main objective is to increase efficiency in manufacturing processes with high-tech strategy and plans. High-tech include technologies like intelligent machines, robots, 3D printing and digital communication. (De Propris & Bailey 2020, 5-8) Digitalization is quite vague term that refers just to implementing distinct digital technologies (Niemand et al. 2021, 317) but is used jointly with Industry 4.0.

According to Korsen & Ingvaldsen (2022, 1059-1061) digitalization, Industry 4.0 and Internet of Things (IoT) plays a role when businesses are trying to digitalize their performance measurement and management. Big data, business analytics and cloud-based systems are giving automatic data which are collected by information and communication technologies (ICT) which can be utilized with modern technologies like Artificial Intelligence (AI). Data and information flows should be used in advantage of opening management related to decision making. This benefits both managers and employees in the organization.

Management of businesses might have been viewed as an art in the past but now data driven decision making (DDDM) has risen as more viable option in recent years. Managers don’t have to trust on intuition but more on data. Organizations are used to trusting a lot on quantitative methods which consist of traditional metrics like sales volume and market share. New opportunities of collecting data brings a whole sets of new information and measures to the executives table. Data driven decision making allows data to transform into usable information that is combined with management people cognitive skills to have a final result of executable knowledge. (Rejikumar et al. 2020, 281-282; Brynjolfsson & McElheran 2016, 133)

Subject of this research is related to different areas of performance measuring and management, data-analytics and business intelligence. In current era, more data is available for usage and managers are eager to see performance indicators which will assist in the visibility and decision making. In a fast-growing pharmaceutical company having consistent measures and wide visibility is important. Knowing the bottlenecks of key processes and performance will help the management, for example in resourcing and scheduling tasks.

1.1 Objectives and limitations

The main objective of this research is to develop performance measures and management in pharmaceutical industry which impacts on visibility and decision making. The following research questions are expected to be answered that main objective can be fulfilled:

- How will data integrated KPIs and metrics drive forward the area of performance management
- How to manage the entire process of centralized metrics to ensure their safe usage and relevant information
- How to design and develop a KPI & reporting framework in a pharmaceutical organization

Answering first question will give result about why data is important in Key Performance Indicators and how it signals to the performance management area. Knowing basic information about performance measures and management especially in modern data matured time is important. Second research question will provide information about KPIs creation, usage and end-life processes. Focus is on ensuring that practical and technical understanding of KPIs occurs in the necessary levels. Lastly information about designing and developing comprehensive KPI & reporting framework in a pharmaceutical organization is provided.

Limitations in the research are mostly in empirical part due to it is focusing to single case company and results might not be valid in any other context. This research's result should still provide some usable information to the pharmaceutical industry but can't be replicated directly to other business cases. Theoretical part is more applicable for general acceptance in the field of this research.

1.2 Method and approach

Method of this research is qualitative analysis. Qualitative research aims to contextualise, interpret, and understand relationships which will give a result to the research question from certain perspective. Usually qualitative research can have interviews while quantitative is based on statistical methods. Qualitative analysis has two points: simplification of observations and problem solving that will be connected in result interpretation. (Alasuutari 2011; Hirsjärvi & Hurme 2022) The qualitative research and case study method is well suited for this research because in the empirical part a single case company is studied that will give a result from one perspective. Empirical parts major contribution is made with interviews which strongly applies to the case study approach.

Case study is often used in current academic researches and has positioned itself among other methods. Still there are debates whether case study can be used as comprehensive research. Hamel et al. (1993, 29-31) also explains that able to have theory or theoretical framework, first must become particular case or cases which theory is slowly build on. Case study is criticized of reliance for common sense and connecting to social actors like own personal experience that can change the research perspective and interpretation. Farquhar (2012, 5-6) describes that a case study investigates phenomenon especially from real-life environment which means evidence and information from, for example companies, universities and countries.

The approach of this research was first to decide research objective. Then the overall plan of procedures and work was designed. Literature review was conducted via academic literature database LUT Primo, and other scientific research engines like Google Scholar. Also few additional sources were implemented from general online websites, like articles, blogs and publications that were viewed to bring additional value and fresh perspective compared to scientific articles. After literature review was underway interview questions were finalized and people to be interviewed decided.

1.3 Structure

Structure of this work is two parted. First theoretical part is presented where literature is referenced in relation of subject. It gives understanding of the subject and can be used later in empirical case. Empirical part consists of two main entities: interviews and their results, and creating a KPI & reporting framework. The findings from interviews and literature are combined to form the framework to the case company. The structure of this research is presented also in Figure 1. To complete the research conclusions and summary are written.

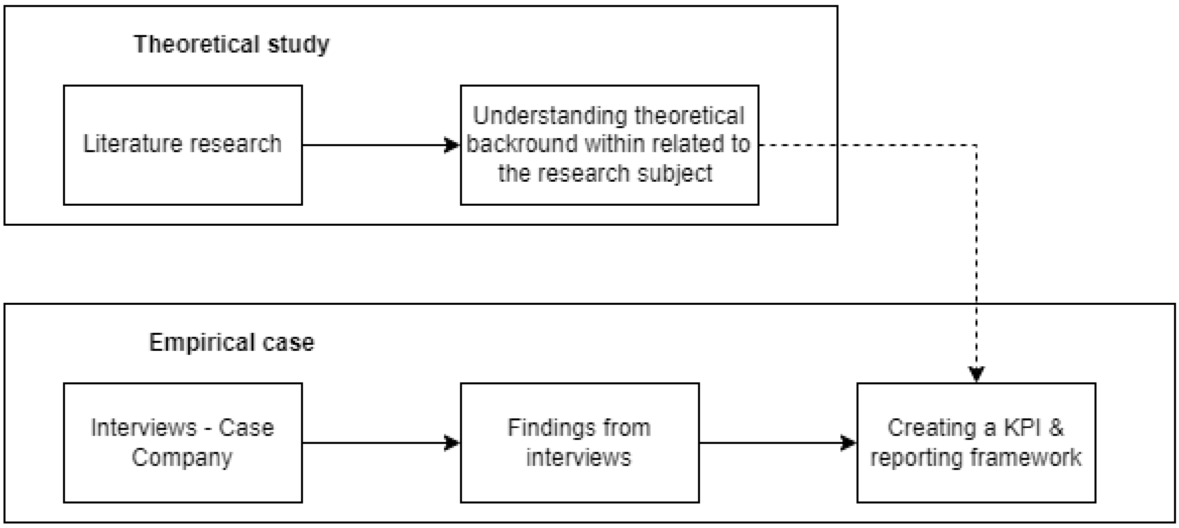

Figure 1. Structure of the research

Theoretical study will have three chapters that creates comprehensive background on literature knowledge. First chapter handles performance management in data driven time which combines basic information from tracking performance with modern business intelligence and data analytics. There is also information about visualisation of reports, scorecards and dashboards. Second chapter practically guides to build Key Performance Indicators and control them with documentation. It also has technical execution perspective of how should KPIs run automatically in reports from business intelligence. Third chapter has information about metrics and KPIs in pharmaceutical industry which is important for the case study.

Empirical case starts with interviews that answers different questions around the chosen topic. Interviews purpose, questions, timeline and results are all explained to validate the interview method. Interview results are essential for the next chapter in case part: Creating a KPI framework for the case company. This chapter focuses on building a practical and usable framework that still can be adaptable if needed. It is a suggestion which includes also plan with relation to the more technical solution.

2 Performance management in data-driven time

This chapter focuses on theoretical findings from performance management in data-driven time. Understanding what performance management is and how it will help on organizations to manage it better. Data is key attribute and more available which should enable performance management to rely on it.

Charles M. Cadwell (2000, 3) defines performance management as following: “It’s a proactive partnership between employees and management that helps employees perform at their best and align their contributions with the goals, values, and initiatives of the organization”. Having committed members to reach the benefits of performance, is a key foundation to success. This means that performance management is planned with employees to ensure it’s a partnership between parties. Cadwell (2000, 4) continues to list the benefits of performance management as follow:

1. Improve performance
2. Improved communication
3. Organization alignment
4. Organization capability
5. Reduced management time
6. Increased employee self-management
7. Increased employee satisfaction

2.1 Tracking performance

Performance management and performance measures has a long history in private sector which begin with financial aspect and reporting purposes. This information was generated to be used inside and outside of organization. Since then more non-financial performance management models have been developed to assist in providing strategic depth to multidimensional problems and changes. (Halachmi 2005, 4) One of those famous models that had combination of financial and non-financial measures was Balanced Scorecard (BSC) which was developed in 1992 by Kaplan and Norton. It had four perspectives: financial, customer, innovation and learning, and internal business needs, that had multiple measures divided to them. (Kaplan & Norton 1992, 72-76) Many companies have modified and continuously improved the BSC to fit their strategic needs and goals. In 2000s more stakeholder orientation and sustainability aspects have been tried to take account in creating dynamic and holistic performance management. (Yadav & Sagar 2013, 3-15)

Organizational strategy plays a major role in business performance which includes productivity, efficiency, profitability, market value and competitive advantage. Identifying success is not purely determined by monetary indicators in modern day companies. Acquiring knowledge and managing it will bring dynamic and innovativeness focus to organizations that have positive impact especially on internal processes and customer perspectives. (Jami Pour & Asarian 2019, 1943-1947)

Establishing a successful performance management process requires many steps. These five steps: plan, monitor, analyse, improve and maintain are presented in Figure 2. Normally tracking performance starts with planning where all expectations are written down. The clearer they are, the better it is. In step 2 monitoring, reaching concession on how to track the performance is at the centre. Once the data is gathered, results are monitored and decision about whether performance is on track is made. If not there are steps 3 and 4 required take and if yes jumping to step 5 can happen. In step 3 analyse, finding gaps and determining the reasons behind lacking performance are studied. The cause gap should be identified for is it worth to invest resources to close or eliminate the gap. Improving the performance occurs in step 4 where correct actions to reduce the gap are decided. In last step 5 maintain, systems presented positive or corrective feedback which can be used for example in compensation and rewards. (Cadwell 2000, 16-18)

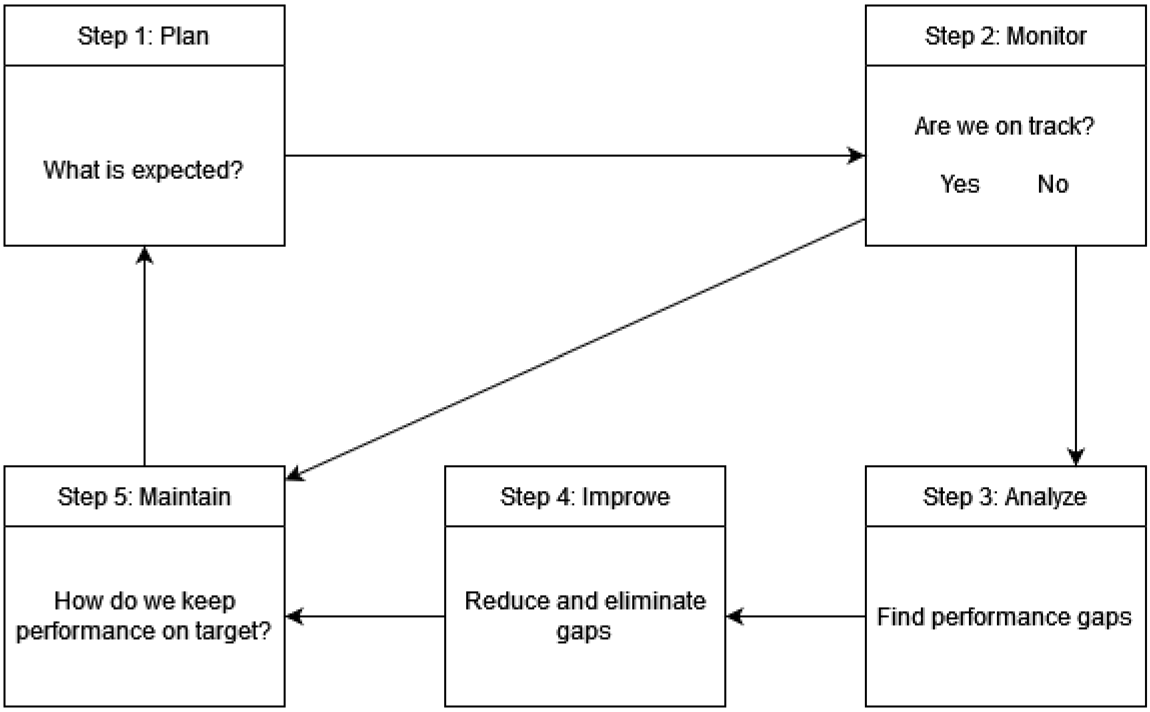

Figure 2. Five steps of performance management (Cadwell 2000, 16)

Traditionally performance management helps organizations to understand its capacity and to monitor the resources more efficiently. Tracking the performance will assist in predictability that is ability to identify future events. What can be measured, can be managed which is crucial when alignment of strategy and operations are trying to be held together. This requires discipline and constant effort to find the gaps that are causing poor performance. Performance management core consists of assumptions where the relationships between objects like human, machines and processes must be realized and understood to improvement can happen. (Pavlov & Pietro 2023, 899-901)

2.2 Data drives organizational performance

Performance management can have terms to it like, Business Performance Management (BPM), Corporate Performance Management (CPM), or Strategic Enterprise Management (SEM) which all relate to origin of having centralised performance management tool and high visibility. (Pugna et al. 2018, 3) For example, BPM (Figure 3) connects strategy and Business Intelligence (BI) for automated performance measuring. BI ties different methods and tools of how to monitor, analyse, and manage organization that has a goal of pursuing data-driven decision making. (Pugna et al. 2018, 4-6) Adopting data-driven decision making has increased possibility and changes of improving organizational performance. New technology implementation leads often to rearranging the necessary related processes and management which gives realization to potential of data as an asset. (Brynjolfsson & McElheran 2016, 133) This puts emphasis on people to be convinced about the data validity where data flows and information systems are playing a role (Pugna et al. 2018, 4-6).

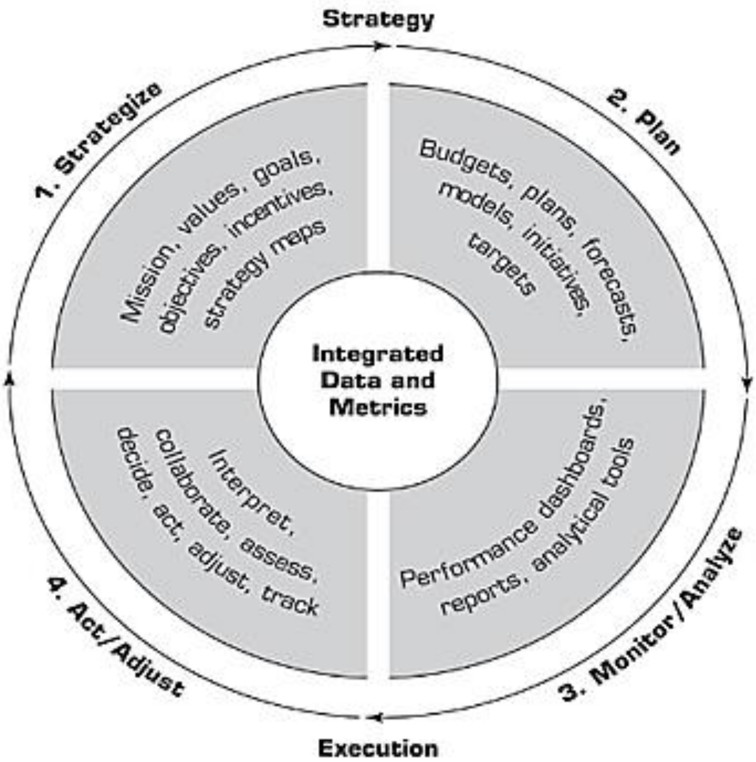

Figure 3. Business Performance Management (BPM) process (Pugna et al. 2018, 4-6)

Integrated data and metrics rely heavily on data management, which include for example, data standards, data architecture, and data governance. This foundation can be utilized in exploitation level where reporting, Key Performance Indicators (KPIs) and other forms of analytics and knowledge are used as source for performance management. Businesses should see data as a similar asset to property, cash in bank or inventory. (Wallis, 2021 41-42) Data itself does nothing to increase efficiency or performance but when people, process and technology are combined to work together as a unit, improvement is expected to happen. This is presented in Figure 4. (Wallis 2021, 44)

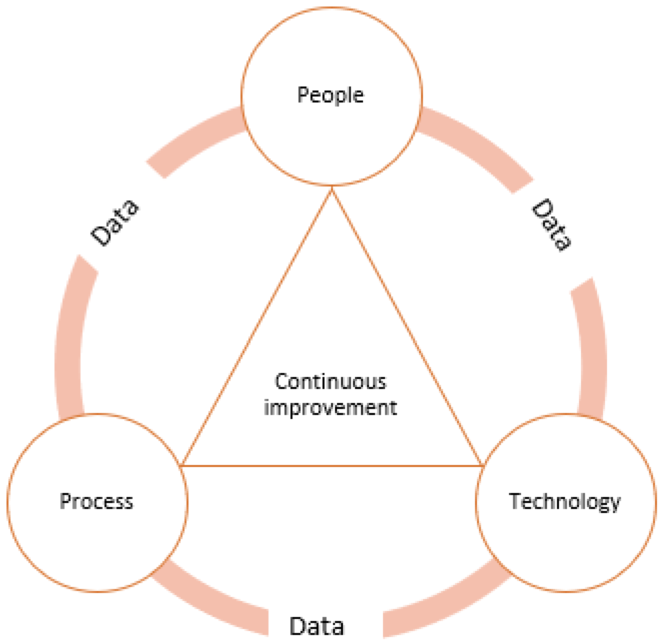

Figure 4. Data enables organizational improvement (Wallis 2021, 44)

Data-driven culture enhances important business drivers that lead to improvement in organization performance. Dynamic of global business environment forces companies to adopt preventively to upcoming changes in market, for example in product innovation. Innovation with data-driven approach from various sources needs resources that are legal, human, financial, relational, informational, and organizational. Succeeding in optimizing the management of heterogeneous resources will increase the performance notably in processes. (Chaudhuri et al. 2021)

Organizational performance is affected by multiple factors, one of them is stakeholder groups. When assessing organizational performance all stakeholders must be considered when score is given. A sustainable business that seeks advantage, builds better relationships with employees, customers and suppliers. (Škerlavaj et al. 2007, 351) For example, in research by Kumar et al. (2020, 33-35) determining relationships between supply chain quality management and organizational performance in retail industry was studied. They tested data driven – angles with leadership, customer focus, training, and employee relation against organizational performance. Results had positive indications that the mentioned angles influenced performance in the organization which should in long-run create more business value. (Kumar et al. 2020, 35-38)

2.3 Analytics and performance management

Recent analytics development has given tools and instruments for performance management. Due to increasing amounts of data with complex and volatile systems, analytics, planning and predictive modelling is expected to be used for helping to deal with problems. These problems erase from markets becoming more competitive and finding advantages is viable for competitive edge. Analytical approach can help to discover hidden potential, causality between objects and new aspects that can be executed in different levels. These strategic and executional levels can be found in all functional areas of a company, for example in supply chain or human recourses. (Schläfke et al. 2013, 2-4)

Schnegg & Möller (2022, 242) describe the relationship between data analytics and performance management as follows: "Consequently, three positive performance management outcomes use data analytics: increased efficiency, accuracy, and a better understanding of the business drivers". Kokina et al. (2017, 51) confirms the meaningfulness of data and analytics has very crucial part in successful performance management and measurement. Data analytics has great potential, for example in forecasting problems in supply chain management and financial aspects. This will increase the business performance due to adaption and decisions can happen beforehand with data. Problems might occur from existing legacy systems that has long reflection on organizational culture and processes. Changing the system will bring changes to the processes and ultimately to people habits of working. Failures in implementation of data analytics might setback usage of analytical capabilities, and thus decrease data's effect on business performance. (Schnegg & Möller 2022, 242-244)

2.4 Dashboards, reports, scorecards

There are different types of ways how to visualize performance to people and management. Most commonly used are scorecards, reports, and dashboards to show our KPIs and measures. Visualisation can have significant impact on how management makes decisions that leads to growth and financial success. It is used as diagnostic of positive and negative indicators. (Kokina et al. 2017, 51-53)

As previously mentioned Balanced Scorecard (BSC) is one the most common used performance management framework for businesses. According to Anand (2016, 26-29) BSC has four perspectives: financial, customer, internal processes, and learning and growth which consists of multiple measures. The perspectives have slightly changed from Kaplan's and Norton's original article (1992, 72). The scorecard is element of strategy where the company is heading towards, focus is on executing strategy not making one. (Anand 2016, 26-29; Malagueño et al. 2018, 2-3) BSC is two parted with a strategy map identifies top 20 strategic objectives, and the actual scorecard part where objectives are joined with related measures (see Appendix 1, example). It has also designated owner for each objective and a target or goal for each metric. (Anand, 2016 26-29) A noteworthy assumption in the BSC is "performance measure is part of a balanced cause-and-effect relationship in which leading measures (e.g., non-financial, drivers of future financial performance) drive lagging measures (e.g., financial, results of past actions)" (Malagueño et al. 2018, 3).

Performance dashboards are expected to gather, summarise and introduce information to management but generally there are no concession about what dashboard should look like and what it supposed to do. Dashboard's value is linked to the organizations ability to utilize it effectively. Dashboard presents glimpse of data and if it is necessary drill down to deeper analysis, such knowledge can be offered where causes of poor performance is hopefully figured. Dashboard can be static or more modern which includes features like interactivity, scenario-based actions, or automated alerts. (Yigitbasioglu & Velcu 2012, 42)

Reports differs from dashboards due to report usually holds much more detailed information and has more visuals in it compared to dashboards. Dashboards are usually single page views that tells end-user necessary information in one minute at higher level. Report is also wider term in sense of its usage. (Chartio 2018) Performance measurement and management recognize dashboards and reports by design which refers identification in dashboard purpose and features. Purpose means what is the dashboard idea, for example performance monitoring or planning, and features include functional and visual features that user views. (Yigitbasioglu & Velcu 2012, 48)

3 Building KPIs and metrics via standard process

Twin (2023) defines Key Performance Indicator (KPI) only to be quantifiable measurements, while Bishop (2018) suggest that qualitative measures can be also considered as KPIs. These key metrics guide businesses long-term performance with specific connection to strategic, financial, and operational achievements (Twin 2023; Bishop 2018). Measures are usually compared to set of targets, goals, objectives, or industrial averages. Most of KPIs are financial, customer-focused or process-based ones while they can differ largely by industrial field or even by single company. (Twin 2023) KPI definition can be seen quite broad but still all metrics shouldn't be viewed as KPIs. Key Performance Indicators show to the management level how organization is performing based on the critical success factors (CSFs), and they are crucial in the success that company has currently and in future. A performance metric can be tied to a team or a cluster of teams working toward the same goal which gives clarity and ownership of the certain KPI. (Parmenter 2020, 55-58)

3.1 Data analysis and KPI process

Data analytics can be described as "application of computer systems to the analysis of large data sets for the support of decisions". It has close relations to other scientific areas like, statistics, machine learning, and system theory. (Runkler 2016, 3) Analysing data will give the suitable information needed for further usage. In the process conditioning, filtering, and other rules is applied to receive wanted end-result, thus data analysis can be seen as complete process for target information. (Khan 2023, 2-3) Data analysis project can be divided to four different phases: preparation, preprocessing, analysis, and postprocessing. In Figure 5, steps that occurs inside of the phases are described. (Runkler 2016, 3)

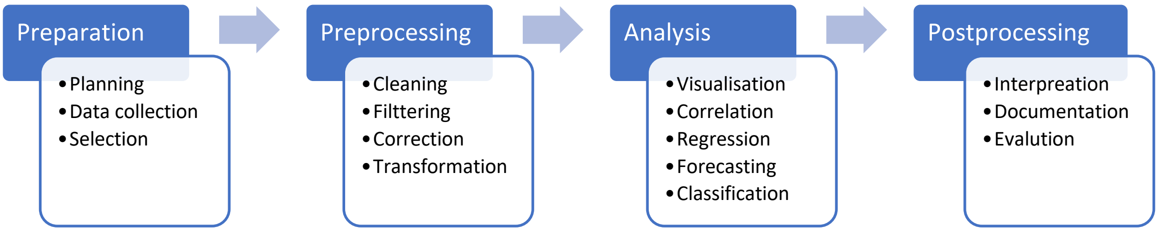

Figure 5. Phases of data analysis project (Runkler 2016, 3)

Very similar steps can be followed with KPI and metric building process. Usually KPIs should be build in-house by small team if the organization has enough resources and skills to complete the process. Running workshops with business stakeholders and end-customers is an efficient path to knowing what the needs of individual departments are. Presentations and communication are highly suggested for management side. (Parmenter 2020, 99-103) Deciding a correct key performance indicator is dependent for example, on industrial field, specific company, and unique requirements. They should feed the foundations of business strategy goals. (Bishop 2018) One concept, 3Ms: meaningful, measurable and manageable, could be helpful for selecting the correct KPIs to have. Meaningful metrics are relevant to closest stakeholders, measurable ones should be easily trackable and identifying the perfect KPI might not be best approach, and manageable KPIs are controllable and help in decision making. (Szalay 2017)

Once the indicator is decided, a perspective and metric formulation will be generated to match what is trying to be measured. All relevant parties should know the formulation that discussions about metric not showing correct are few as possible. Each metric is dependent on data source or if there is even data available which will impact to KPI formula or if metric can be created at all. (Anand 2016, 74-78) Common frequency to KPI for high level management is monthly or certain cases quarterly. At operational level the metric frequency can be daily or even hourly which helps especially individual team management and work culture. However, process development is not often seen in very short periods which should kept in mind. (Bishop 2018)

Unit of measurement is usually decided between actual number and percentage, for example profit 1M vs 4% (of revenue). Even both can be shown in same measure if it's necessary information. High management should choose objective units that help tracking KPIs consistently and don't hide weak performance intentionally. Decimals should be rarely used, and big numbers are suitable for rounding and letter shortenings e.g., 1.1M$ vs 1,103,200$. (Anand 2016, 80-82) Signal colours next to metrics, like red and green are beneficial to view how KPI is performing against chosen target, behind red, ahead green (Bishop 2018). This needs to be done with care due to people might see red signal as something is broke instead of, we are just lacking slightly behind from the target. Using triple green, yellow, red signals is more precise for middling performance.

3.2 Centralized KPI management

There are many paths to managing KPI and reporting in businesses. Dashboards and scorecards can be divided to three data insight levels: Strategic, tactical, and operational. Strategic level gives most summarized information while operational is quite transactional data, and tactical sits between. They are used differently and by distinct people but should serve and be connected to identical company goals. (Pugna et al. 2018, 2-3) For example, inventory value by strategic depth is whole value on quarterly basis, by tactical divided to raw materials, components, finished products on monthly basis, and by operational depth contains information like per product on weekly/daily basis with opportunity to deep dive to data.

KPIs and reporting can be structured in company to match organizational hierarchy model (Figure 6) which is easily approachable design. There strategic, tactical, and operational levels are part of organization model. Leadership/Board KPIs that have the most strategic view should be updated and managed by bimonthly or monthly. Below departmental/unit KPIs are placed for managers to be viewed monthly or weekly basis. Team KPIs are weekly or even daily updated for personnel so they get constant feedback on their performance. Departments and teams can use organizational indicators if they are relevant for monitoring, and leadership can use lower level KPIs if they are desired. For some transactional based metrics hourly or live updates are beneficial, and they are visible for all personnel, ideally operational staff would view them via info screens like under intranet. (Parmenter 2020, 215-223) Many managers think more KPIs are better, but an organizational person should not look more than 8-12 performance metrics. Too many metrics can lead to bulkiness of information and losing the main focus towards strategic goals. The lower part of organization usually needs even less than eight performance metrics. Number of KPIs is also dependent on the size of company. (Bishop 2018)

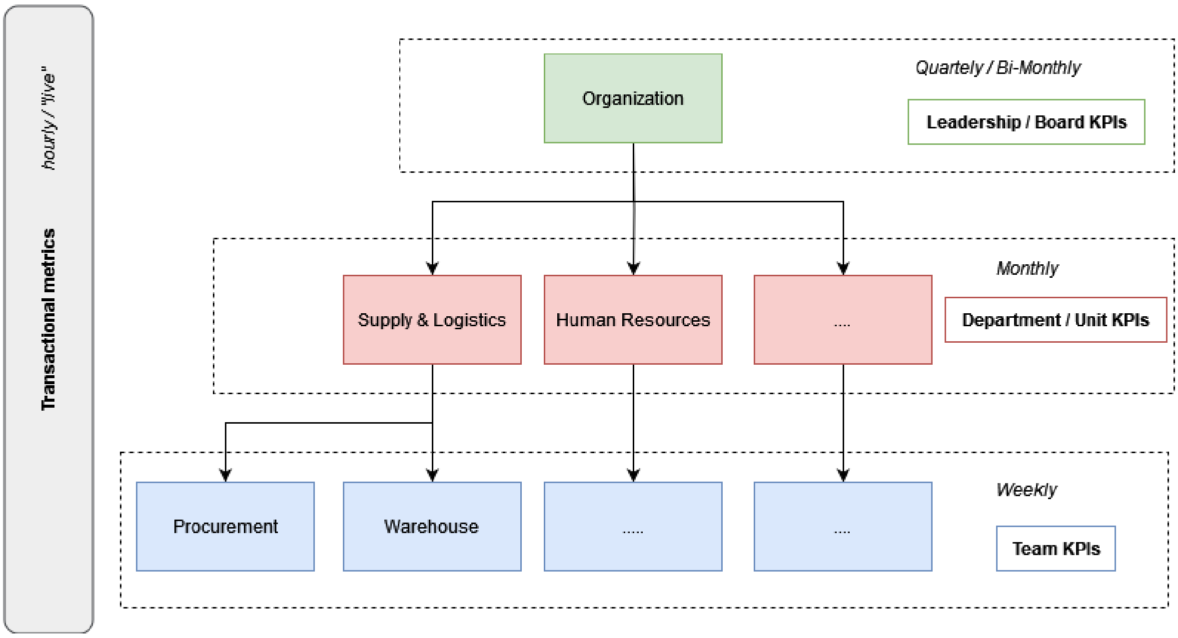

Figure 6. Organizational KPIs structure model example (modified from Parmenter 2020, 215-223)

Measurements are necessary to document somewhere where people can confirm their meaning and purpose. The documentation needs might differ slightly depending on what level KPIs are presented. For organizational KPIs usually an area is defined, like financial, internal process or delivery, and for lower levels they can be simply team name, like warehouse. Measures are connected to objectives, and other information documented could be description, data source (ERP, CRM, etc.), formulation which can be very technical, unit, responsible person or owner and target. Also adding information like, frequency and technical contact is helpful. All measures especially KPIs should be revisited annually for checking if a measure is still relevant and formulation matches what is trying to be measured. (Anand 2016, 67-75) An example of KPI documentation is presented in Figure 7 below.

#	Strategic level	Area	Objective	KPI	Description	Data source	Formulation	Unit	Frequency	Owner	Target		
											Green	Yellow	Red
1	Leadership	Financial	Increase sales	Sales amount	How have sales compared to projected	ERP	Actual Sales Amount / Forecasted Sales	%	M	Mikko Mallikas	Over 80%	80%-60%	Less 60%
2	Leadership	Delivery											
...													
11	Team	Warehouse											

Figure 7. KPI documentation model example (based on Anand 2016, 67-75)

3.3 Technical solutions

Technical tools for creating a KPI and reporting infrastructure in current time relies on Business Intelligence (BI) concept where enterprise applications (e.g., CRM, ERP) are connected to automated reporting and analysing services (Tvrdikova 2007, 364). BI software's where different criteria are evaluated are mostly linked to efficiency, user friendliness, price and adaptability. BI platforms and applications work usually quite independently from operating systems because they need to have ability to compile and analyse high volumes of data without effecting operating systems infrastructure resourcing. Separation also assists in protecting the operational data with correct authorization level. This extraction happens from operating systems to tools like data warehouses and multidimensional databases for analytical reviews. (Fourati-Jamoussi & Niamba 2016, 39)

In building centralized BI reporting, typical approach is that all data is brought to one main data warehouse. This bringing data to one place and preparing it for analysis called Extraction, Transformation and Loading process, known as ETL. Common processing tool in recent times multidimensional/online analytical processing (OLAP) has methods which can be integrated with ETL based or other technology using data warehouses. OLAP cubes are efficient in giving decently real time data, time intelligence dimensions, and different types of modelling, like forecasting and trend determination. (Maaitah 2023, 44-47) Microsoft has brought next to multidimensional OLAP technology, a new tabular OLAP technology that can be seen easier to develop and maintain, and many companies have shifted using it. Benefits of an OLAP solution are compression of data and fast responses in querying and analysis that enables minimal reporting data cycles. (Microsoft 2023a) BI solutions rarely offer precise live data which is wanted by end-user more and more. Reporting software’s are used for summarising and visualizing the analysed and processed data for business management. (Maaitah 2023, 44-47)

4 Metrics in pharmaceutical industry

High quality is a key component in pharmaceutical industry due to regulatory restrictions and the quality must be ensured in all stages of operations. Most recognized drug administrator FDA (U.S. Food & Drug Administration) views quality metrics as an “objective path to measure, evaluate, and monitor the product and process lifecycle”. These KPIs are ensuring that the product is safe, and manufacturer is creating efforts in continuous improvement of operations. However, quality metrics are different from what is meant with drug and manufacturer receiving market approval. It must meet set of quality requirements, and follow compliance and good practises (example GMP, Good Manufacturing Practises). (FDA 2023)

In relation to the quality metrics a research article by Fellows et al. (2022) benchmarked quantifiable KPIs for operational performance in pharmaceutical industry. Reason for this study was FDAs effort to seek connections between manufacturing performance and quality management practises. Total of 208 responded to the questionnaire around the world, mostly in Asia, Europe and Americas. From using analysis of St. Gallen program research determined total of 13 KPIs to four categories: Maintenance, Delivery, Quality and People (Table 1). These KPIs were divided to in peer groups to form a calculated weight which could be combined as overall score. (Fellows et al. 2022)

Table 1. Benchmark KPIs in pharmaceutical industry (Fellows et al. 2022)

Maintenance	• Unplanned maintenance / all time spent on maintenance • Ratio: maintenance full-time equivalent (FTE) to Total FTE
Delivery	• Order fulflment customer: percentage delivery on time/right quantity • Order fulflment supplier: percentage received on time/right quantity • Customer complaint rate / relative to dosage units • Adherence to standard lead time (Lab)

Quality	• Rejected batch rate (relative to all batches produced) • Recurring deviation rate (relative to all deviations) • Ratio: quality FTE to total FTE • Invalidated out-of-specifcation rate (of all out-of-specifcation results) • Average deviation closure time
People	• Safety level: reported accidents • Sick leave as a percentage of total working time

In another research by Torkko et al. (2014) studied a single case company’s quality KPIs and the results were as following for six quality KPIs. Loss, loss incurred during manufacturing or packaging process (%). Deviations, number of deviations related to the manufacturing or packaging batch. Right first time (RFT), manufacturing or packaging batches without any deviations. Complaints, number of complaints/million packages. Observations made in audits and in inspections, number of observations/audit or inspection day is presented as a rolling mean of 12 months. Recalls, number of recalls is presented as a rolling sum of the latest 12 months. According to the source these were implemented in 2012. (Torkko et al. 2014)

5 Interviews – Case: Company

Empirical part in this research is answering to questions about performance measuring and KPI usage in a pharmaceutical case company. This chapter focuses on interviews and their finding while designing an organizational KPI framework is built in next chapter. Interviews will follow half-structured model and are under theme category. In half-structured interview most of the questions are preplanned but additional questions might appear to increase the value and input of answers, and theme interview focuses around certain topics without strict limitations to questions (Muotio 2022; Hirsjärvi & Hurme 2022). More information about the interviews and questions is in chapter 5.1. In next, the case company's current situation will covered shortly and anonymously related to performance measuring and reporting. Anonymous is caused by very protectoral perspective towards information and data in pharmaceutical industry. Lastly results and their analysis is done.

Case company works in the pharmaceutical industry of GxP ("good practises") environment and has based its production on viral vectors. The case company has seen quite rapid growth is recent years which has created more need to measure performance and visualise it. As a part of pharmaceutical industry where information and data validity plays a key role, data-driven approach should be easier to implement and develop for business needs comparison to other industrial fields. This still requires effort from people to accept integrated metrics and KPIs.

5.1 Interview method and questions

As previously mentioned, this research is done via interviews and they follow half-structured model that gives deeper understanding of performance measuring. Performance management and measuring is mostly controlled by site leadership or top management thus the target interviewee group in the case company was manager level. One equal management level was seen best to give comparable results. Eleven managers were chosen for the interviews and they presented different departments and areas that would give a more precise result of the whole business. The respected managers were from five departments:

Manufacturing, Supply & Logistics, EHS (Environment, Health & Safety), Quality, and Engineering.

The interview composed of three themes which under were 6 main questions plus sub questions, like requiring specification. Also additional question may have been presented if needed. The amount and subject of questions were chosen based on how they would link to the research agenda, and would be simple for interviewees and result interpretation. Time used for the interviews was also a constraint in the background due to managers might have been busy.

Interview themes and questions:

A. Current situation

1. Are there defined objectives for your unit/area? (main objectives, amount)
2. Are you measuring the performance against the objectives? (what type of tracking is used, e.g., KPIs or other - Specify)

B. Development

3. What measures or KPIs should be added? (Specify: amount, what)
4. Would wider organizational visibility of KPIs & reporting be beneficial?

C. Technical aspect & tools

5. What tools (e.g., excel) are currently being used for managing KPIs, and are they taking too much of time or hard to maintain?
6. Would automation of KPI tools and reports optimize the usage and control?

Interviews were kept either in person or in Microsoft Teams and the language of interviews were Finnish or English based on what was most convenient approach per interviewee person. Schedule of the interviews is presented in Table 2 below. All of the interviews were recorded via Microsoft Teams recording function for analysis and results phase. Recordings were saved in MP4-format and transcribed to excel in English per interview with interest only content of answers. Transcription process was made using summarising and saving certain quotes method, not specifically word to word but still keeping necessary information. This ensured that analysing the data retained its validity even though time may have passed from the actual interview. If something was required to recheck or add, recordings were still available for interpretation during the analysis phase. After this research was finished the recordings were deleted.

Table 2. Schedule of the interviews

Code	**Date and time**
Interviewee 1	20-06-2023 13:15
Interviewee 2	21-06-2023 10:00
Interviewee 3	26-06-2023 10:30
Interviewee 4	27-06-2023 10:00
Interviewee 5	04-07-2023 14:00
Interviewee 6	06-07-2023 10:00
Interviewee 7	12-07-2023 09:30
Interviewee 8	13-07-2023 10:00
Interviewee 9	25-07-2023 14:30
Interviewee 10	26-07-2023 14:30
Interviewee 11	27-07-2023 09:30

5.2 Interviews results

In this chapter the results of interviews are presented under each theme and question. Answers will be shortened and analysed together and original quotes from interviewees are used in supporting the analysis. All of the planned 11 interviewees participated to the empirical case research.

5.2.1 Theme A - Current situation

Are there defined objectives for your unit/area? (Main objectives, amount)

Most of interviewees had defined objectives for their unit or department. Usually the amount of main objectives was between 1 to 4 for each and at least one of objectives was related to the quality KPIs (Deviations, CAPAs, etc.) which were followed by all departments' manager. Even though some of departments had objectives they weren't really directed to their area but can be seen to serve broader clustering of teams or even the whole organization.

Interviewee 11: "*We don't really have measuring tools but the objectives and criteria's I would say are quite clear at least in company basis.*"

While other departments had clear vision some of the responses are seen slightly unsure about their situation mirrored to the objectives. Objectives are not clearly written, decided, are quite old or don't have ownership dedicated to them. Couple of the interviewees brought unsureness up as following but were still hopeful about future.

Interviewee 5: "*Currently we are kinda in intermediate stage and objectives will be redefined shortly.*"

Interviewee 8: "*Objectives are not really properly defined. Target is to decide and write them this year clearly. We will use some made reporting as a backround for objectives.*"

Are you measuring the performance against the objectives? (What type of tracking is used, e.g., KPIs or other - Specify)

Answers varied more in this question based on department. Basically all of the departments were either following or tracking their progress but not real KPIs or metrics were used in many cases. Also what is tracked may not have been used against the objectives but is rather seen important to follow. Interviewees recognized that they should move towards using proper performance indicators and having more centralized and focused approach controlling them.

Interviewee 1: "*We don't have many KPIs but we measure few things. It's not real measurement but let's say follow the activities. We should slowly to move towards KPIs"*

Interviewee 10: *"Not specifically centralized tracking approach via KPIs or metrics but instead we are following our progress."*

Most advanced departments in terms of KPI usage were EHS, Engineering and Logistics. They had created solid metrics for measuring the performance against the chosen objectives. This ensured monthly or weekly standard meetings the results were presented to the all personnel inside of department. The managers saw KPI approach to help in decision making and controlling of their department,

Interviewee 4: *"Once a month we look together with our department how are we doing."*

Interviewee 7: *"With our current KPI reports we get data directly from ERP system. This helps us to guide decision making and control at our unit."*

Interviewees followed their progress weekly or monthly basis while daily checkups weren't mentioned. Most commonly historical measuring was happening using formulas like 'Actual vs Planned' especially in manufacturing and supply & logistics. This was visualized in timeline of monthly bars to track the progress. Managers were also interested in looking quality issues and KPIs those they had responsibility for. Timeliness of past progress and current open issues were viewed a lot in form of 'ontime/overdue' which was related to many object having due or target closure date.

Interviewee 6: "*We are checking a lot of timeliness with in our open issues. Are they ontime, or is some data missing."*

5.2.2 Theme B – Development

What measures or KPIs should be added? (Specify: amount, what)

Surprisingly interviewees had unified perspective in what KPIs should be added even though departmental difference arose like they should. Answers commonly mentioned metrics from processes related batch release and batch manufacturing records (BMRs) to be had in reports. Also improving and validating current KPIs was seen important by almost all interviewees, this was especially noticed in answers that had poorer current KPIs. Improvement was expected in quality indicators where lack of department and team level filtering was seen as an issue. More leading indicators as counterbalance for lagging KPIs which was mostly used, and having a combined index, were mentioned by progressive answer.

Interviewee 2: "*Current and few new KPIs especially leading (not lacking) that would be combined to an index to create a more holistic view. This index is easy to show how are we performing.*"

One interesting view was related to resource usage and are they in sustainable path which impacts on certain result how have it been reached. While another answer brought up project side is lacking KPIs.

Interviewee 3: "*Measure what has been capacity of resources, how have they been used. Especially count of overtime working hours used would be great.*"

Interviewee 4: "*Project side is missing KPI/KPIs. There should be more development for performance measuring.*"

As expected there was differences by department what metrics to add. The following list is combined from each department what they would see best to have in future for tracking performance and leading the employees. Some of the propositions were quite precise while other stayed in general format. EHS saw mostly increasing accurate and visualization of current KPIs.

Manufacturing:

- Planned batches vs Actual finished batches
- Resource usage (per batch)
- Product lead time – From drug substance to customer

Supply & Logistics

- Yield (per batch) – Components vs Outcome
- Timeliness and description of shipments
- Vendor OTIF (OnTime InFull) – Actual Delivery Date vs Expected Delivery Date

Quality

- Batch records
- Test sample analysis started ontime
- Test sample result reviewed ontime

Engineering

- Breakdown time
- MTBF (Mean Time Between Failures)

Would wider organizational visibility of KPIs & reporting be beneficial?

Common result for having wider visibility of KPIs was seen positive. Managers weren't afraid off showing poor performance but saw it as change to improve and even inspire employees to view on their progress because visualisation of progress is better than talking about it. Some though that every KPI should be public while other didn't have a strong opinion on the matter but weren't against of public metrics. As a valid concern too many KPIs shouldn't be shown to people as information can be overwhelming.

Interviewee 9: "*It would inspire people for seeing in visual how have we progressed during this year. No work would remain hidden but instead more concrete information should be visualised better, visualisation usually much better than just talking about it.*"

Interviewee 11: "*The only comment here is that it should be applicable to certain departments because you can be overwhelmed by the information which is not relevant to your operations. If people can pick the necessary KPIs to track their activities would be good.*"

Managers were eager to view on performance of other departments. They recognized that own success doesn't automatically bring success in organization level. Due to fact many departments are co-working and events are dependent on factors next to them, seeing larger picture would be helpful.

Interviewee 5: *"It would be nice if we would see also situation of other areas. Automatically own success doesn't mean that next to you everything is working."*

Interviewee 1: "*Today many department working in silo, if giving big picture people would understand better their role in a chain of events, what is happening before them and after."*

KPI and reporting visibility on info boards (big screens in spaces of company building) was mentioned quite a lot from interviewees. Employees would see organizational and their own department progress in one slide of screen which consists of most important KPIs. The current usage of info screens wasn't seen optimized.

Interviewee 6: *"Would be interesting to see performance of the whole "house" and compare it to unit ones. We have these white boards (=info screens) which are displaying different types of info but they could be better utilized. Publish to them objectives, organizational KPIs and unit KPIs to show how we are doing."*

5.2.3 Theme C – Technical aspect & tools

What tools (e.g., excel) are currently being used for managing KPIs, and are they taking too much of time or hard to maintain?

Most answers for tool managing current performance progress received Microsoft Excel. Excel was best viewed as daily working tool instead of having full KPIs there. Lot of managers were taking information manually from different systems and pasting it to excel for summarization and tracking weekly progress. This manual input process was quite easy to execute but rather took time and effort which could be utilized elsewhere. It was seen as unideal method however without alternatives developed properly it is better than nothing.

Managers recognized excel also to be vulnerable for errors either in inputting data or calculating it.

Interviewee 1: *“Excel is useful for daily working tools. Not best for having summarized measuring and KPIs, you can have formula errors for example.”*

Interviewee 5: *“When I really want to look everything properly, it takes around 15min.”*

Interviewee 2: *“Is quite easy to manage currently but if more KPIs and information are added, will be more time consuming.”*

Other tools mentioned by interviewees were Microsoft Power BI, internal manufacturing timetable and Microsoft Project. Basically those who had usable Power BI reports found them very easy to use and straightforward. BI enabled diving to different levels of data which was positive. Power BI reports was mostly viewed by supply & logistics and engineering while rest of departments had excel as main tool.

Interviewee 7: *“Currently using mostly Power BI tool. The usage is very simple, especially diving to different and smaller datapoints and -views“*

Tools to manage KPIs and progress were viewed fragmented and lacking unity which didn’t directly appear in lines of words but could be interpret from everyone having different tools. This could lead to losing the big organizational picture if more centralized appoint of approach wouldn’t be implemented. One interviewee referenced subject as follows.

Interviewee 3: *“Current tools usage is very fragmented and lacking unity. Everyone has their own excel which can show different results based on data source and quality of manual input.”*

Would automation of KPI tools optimize the usage and control?

Automated KPI and reports were viewed helpful by 10 of the 11 interviewees. Most important benefit was removal of manual work because even though it might not take more than 10min per week from manager to input data, all of the work is duplicated per manager and every week after week. Thus saved time would be counted in hours per month probably. Benefits were also improved workflow and avoidance of mistakes in formulas and data. Automatically updating data and reports showed progress constantly without linkage to user interaction.

As a negative side some saw automated reports not as necessary because same work can be done manually also. Concerns were raised from data quality, data infrastructure, formula correctness like showing what is trying to be measured, and lack of visual design. Data quality was mostly related to everyone should use master systems right while data reporting infrastructure had missing systems which hadn't been yet intergraded.

Interviewee 11: *"Not necessarily, it is only easier for us but we can do it manually also. Automatic reports need to be correct and visually more pleasing."*

Interviewee 7: *"It is important that everyone uses master data systems (e.g., ERP) correctly and reports are automated from these."*

Further development in automated KPI and reporting was still needed. This required more centralized approach and tools be as automatic as possible. One suggestion was related to ready-to-use layouts which would create unity in report structure. It would remove dependency from managers creating individually tools to track their department's progress. Centralized approach also had view that all KPI and reports should be in one place what was necessary to see from managers' perspective.

Interviewee 10: *"We should have ready-to-use layouts or tools in our organizational for tracking and managing the performance. Now it is quite dependent on a single manager how he/she tracks progress and what tools are used."*

Interviewee 7: *"Instead of using own excels and picking data manually to it, we would have centralized reports in one place."*

As a summary from the interviews, KPIs should be aligned better against objectives, and more KPIs is needed. Also current metrics should be improved and documented accurately in future. Wider visibility in KPIs and reporting was seen positive among the interviewees especially the use of info screens in relation to showing the progress for employees, are expected to increase. Some managers had started to use automated Power BI reports which has positive impact on viewing experience, data quality, and time saving. More unified and centralized approach was hoped have in overall KPIs usage, tools, and reporting layouts.

6 Creating a KPI & reporting framework for organizational management

This chapter is the second entity in empirical phase of the research. The focus will be on providing an organizational KPI & reporting framework for the selected case company in pharmaceutical industry. Suggestion includes also plan for implementation of the framework and standardisation in report and dashboard layouts.

6.1 KPI & reporting framework suggestion

Suggestion will take into consideration case company functions, specialties and ready having metrics, industrial normalities regarding to KPIs, and theoretical findings from literature. It also has expertise from the researcher in working at the field during this study. The suggestion categorises KPI & reporting usage to five main modules: info screens, quality metrics, department KPIs, business unit dashboards, and organizational KPIs. Framework is shown in Figure 8 with y-axis having level of data and visual summarization, and x-axis having recommendation when module should be or is viewed by end-user, daily, weekly, monthly and quarterly. Modules insist of different types and number of reports and dashboards, and can have linkage to other modules in sense of sharing KPIs, views and visuals.

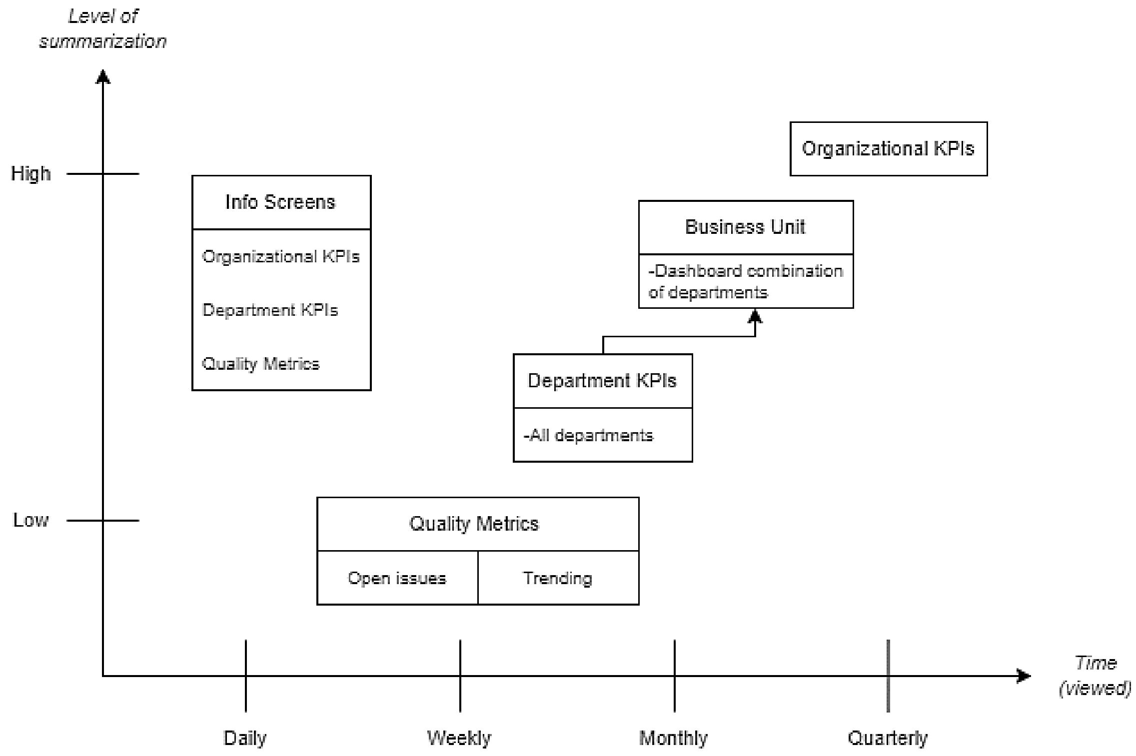

Figure 8. KPI & reporting framework suggestion

Info Screens should display information in form of simple visuals that includes 3-4 changing slides. One slide for organizational KPIs, one for departmental KPIs for the employees of department where that info screen resides on, and one for quality metrics also with only those issues that belong to the specific department. Basically info screen summarizes, collects and copies most relevant information to employees from other KPI modules. One slide should display only highly summarized few visuals and key information, for example not all quality metrics. This approach is best due to employees are looking info screens in corridors, lobbies and lunch areas, and quick peak is usually what they will use to view the screens.

Quality Metrics will include two different reports, one for showing open issues and another for trending which means historical data for closed issues. Quality metrics are for all organization to be viewed regularly and they will include at least Deviations, CAPAs and Change Control (CC) requests. Open issues should be viewed couple times in a week while trending once or twice in a month. Open issues reports are simple working tool for checking timeliness and situation of issues which need actions to be closed. Main visual for open issues is table. Trending reports should show more information and visuals like bar and line charts compared to open issues. In trending user is able to pick the dates or timeline of issues and report visuals will update accordingly, standard should be last 1 year (=last 12 months) or this year.

Departmental KPIs should have all departments presented. Suggestion for appropriate amount of main KPIs is 3-6 per department. These KPIs can be divided or transferred to sub-metrics for smaller teams inside of the department. Department KPIs should be viewed monthly or bi-weekly within designated meeting or under department meeting. Progress is available for employees, but management is the one responsible and owner to the indicators. In the following Table 3 recommendation for three main KPIs for each department is made that is based on interviews, literature, and researcher's personal expertise at the field of pharma during this study. This suggestion includes the departments that were presented in interviews at section 5 with exclusion of EHS.

Table 3. KPIs recommendation for departments

Department	**KPIs**
Maintenance	• Unplanned maintenance time of all maintenance time [%] • Planned maintenance completed ontime [%] • Maintenance FTE of total FTE [%]
Manufacturing	• Rejected batches of total batches produced [%] • Right First Time – Batches without deviations of total batches produced [%] • Resource usage – Overtime hours (manufacturing personnel) of total batches produced [Ratio]
Quality	• Deviations closed ontime of all deviations closed [%] • Test samples reviewed ontime of all test samples reviewed [%] • Quality FTE of total FTE [%]

Supply & Logistics	• Customer OTIF – Order delivery on time/right quantity to customer of all customer deliveries [%] • Product Yield – Components vs Outcome [Ratio] • Vendor OTIF – Order from vendor on time/right quantity of all vendor orders [%]

Framework has Business Unit as fourth module which can have two purposes based on wanted direction in Key Performance Indicator usage. Unit visuals should follow dashboard style where data is combined from layers below. Dashboard shouldn't have any filters on it but rather simple one page view compared to layers below that can have multiple views and filters. Based on department size and organizational structure unit can be a large and key department which have many sub-departments that will form the unit. On other hand, unit can be combination of related departments which have similar working style or goals, for example support unit. Both of these approaches can be utilized at the same time. Unit dashboard regular viewing has ability to switch with business user needs, monthly preferably, bi-monthly or quarterly.

Organizational KPIs are last module in the framework suggestion. They are high level indicators for tracking how is organization doing or progressing in certain period of time. Organizational KPIs should feed the foundation of departmental KPIs so that they aren't fully independent of each other. Usually organizational KPIs are divided to respected areas where they are seen to have impact. These areas are normally, for example finance, customer and delivery. Organizational KPIs regular viewing recurrence is quarterly or bi-monthly or monthly based on organizational size and how are other levels used in KPI management. This viewing should happen with designated meeting of most high level management in the organization. Lower usage of KPIs in other level does create need for having this meeting more often.

6.2 Implementation plan for KPI framework with Business Intelligence platform

Implementation of the KPI & reporting framework should happen via Business Intelligence (BI) platform. One tool for this is Microsoft's Power BI which is united and scalable solution for BI and data analysis. It offers multiple hundreds data source integrations from Excel to SQL Database either in cloud or local systems. These data sources can be connected to each other and modelled for the visualization purposes. Visualization creates interactive reports and dashboards that are shared among the people inside of the organization. Power BI platform consists of local desktop app and cloud service. Desktop app is for building the report and data model while cloud service enables sharing the reports across the organization. (Microsoft 2023b)

Power BI will be a good option for the case company due to possible number of direct integrations to the Microsoft infrastructure that includes tools and instances like power automate and analysis services. Power BI is very versatile tool and can work for both modelling and visualization aspect but in the case company Power BI will be used more as reporting, visualization and sharing software rather than modelling the data.

Business Intelligence platform usually exists from data source to end-report and all stages between them. In Figure 9, there are multiple possibilities for data flow (arrow) in a BI system. All data sources should be integrated to data warehouse (DWH) that works as "one truth" source when building centralized information for KPIs and other reporting. Number 1 in the figure describes quite simple approach with having data source, data warehouse and Power BI report as its components. In this scenario DWH does all transformation while Power BI is having the modelling and visualization.

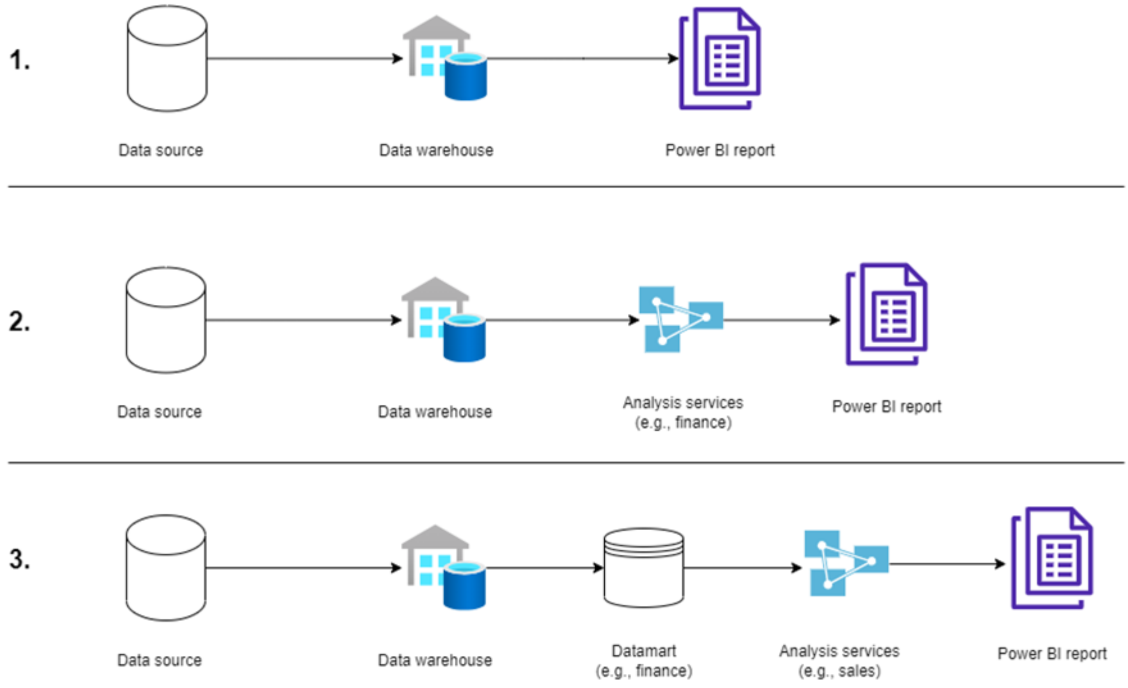

Figure 9. BI system single data flow paths from data source to report

In the second scenario Analysis services is added to the model as the modelling option which leaves Power BI as more visualization tool. Analysis services is basically tabular cube(s) with dimensions and relations build in it, and there is multiple cubes from DWH data divided to clear usage, for example finance cube. To the analyse phase adding modern technologies like Artificial Intelligence (AI) to spot data differences and causality between objects is possible. This is especially effective when working with large volume and unstructured data. Analysis services uses the same engine as Power BI (Microsoft 2023c) that decreases amount of technical learning person has to do in querying and formulation languages when platform has unified technology.

Third option introduces more data storage sectioning having datamart or similar type of solution dividing the data after data warehouse to smaller pieces. This will help in providing security, access and resource management when BI platform grows too hard to control from option 2 which is usually related to increase in data volume and flows, and organizational growth. Then tabular cubes are more functionally targeted, for example sales cube versus finance cube in option 2.

For the selected case company combination of options 1 and 2 would optimal solution. Option 1 would be mostly used in ad-hoc reporting where report target audience is small and quite specific. While option 2 would form the basis of BI system and most of KPIs and reports is connected to the analysis services. Option 2 would create more allowance end-users to connect to the tabular cubes and build own reports.

In future few other technologies for BI development would be to use are datalake or data lakehouse that would make possible of having semi-structured and unstructured data alongside structured data (Lorica et al. 2020). Garces-Erise et al. (2020, 31) sees datalake promises on having all enterprise data in raw and enriched form. Unstructured data includes images, videos and audio formats that can be processed using AI. Datalake and data lakehouse are viewed as more flexible and having higher performance than traditional data warehouse approach. (Lorica et al. 2020; Garces-Erise et al. 2020, 31-32) The approach differences are shown in Figure 10.

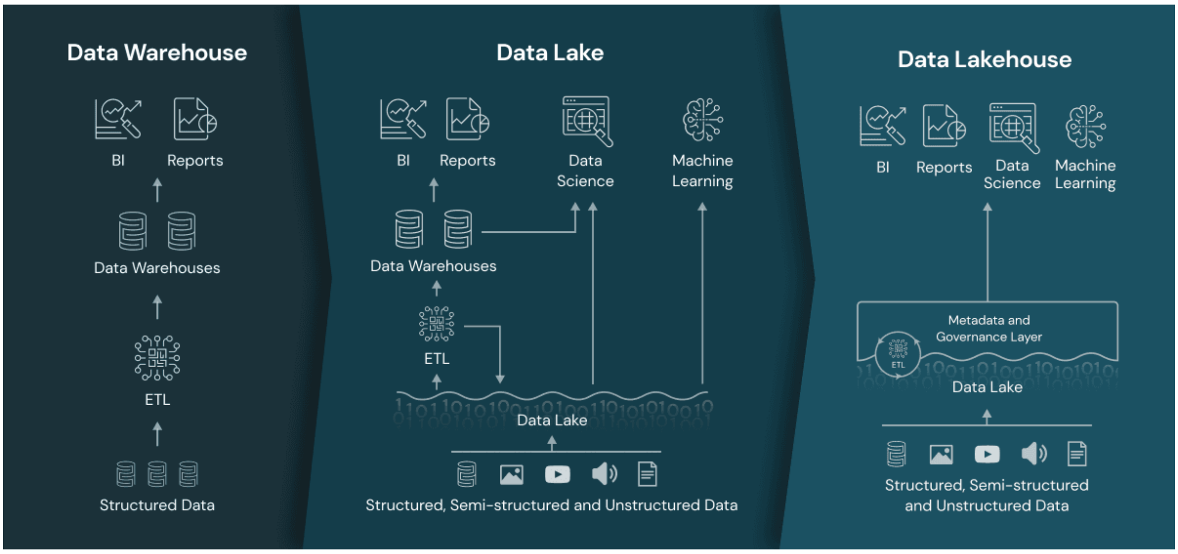

Figure 10. Datalake and data lakehouse approaches (Lorica et al. 2020)

Ensuring that reports and KPIs are correct and showing information which is meant to show is crucial when using automated data. Data quality is related that all data is updated according to refresh scheduling and tables has relevant data in it. For example, if we look how many batches have been produced, comparing ERP system and BIs report values can show if data is transferring accurately. This testing is easier than when trying to figure out if filter and formulation is correct. For example, KPI *Rejected batches of total batches produced [%]* is based on produced batches table and its formulation must be approved and realized by necessary parties involved. With Power BIs Data Analysis Expression (DAX) the KPI configuration could look as follow.

```
Rejected Batch Rate (%) =
VAR _batches produced = DISTINCTCOUNT (Produced Batches[Batch Number]),
RETURN DIVIDE(
        CALCULATE(_batches produced, FILTER(Produced Batches, Produced
        Batches[Status] = "Rejected"))
        ,
        _batches produced)
```

The DAX expression would have variable (VAR) for calculating how many batches have been produced. Variables are very usable in DAX formulating due to it can be referenced many times in future calculation. Another option is to have common measure for produced batches. Distinctcount separates all unique batches and removes duplicates, which is origin of pharma being batch-based manufacturing. Then dividend is number of produced batches that has been rejected, in this case filtered by status field where informing about rejection and completion resides. To get ratio this rejected amount is divided with batches produced amount and transformed to percentage. For example, total 100 batches is produced and 10 of them are in status rejected and 90 in completed, thus DAX result would be 10/100=0.1 that is 10% for *Rejected Batches [%]*.

6.3 Report and dashboard layouts

When designing report and dashboard especially for KPIs it would be help user experience if they had common layouts. This would improve positively management personnel perception towards reports when they are changing from report to report and visuals are in similar place than in other ones. Finding necessary information would happen in minimal time and taking quick looks at visuals would describe the KPI result and progress.

Key Performance Indicator report layout will look as designed in Figure 11. Example layout has three visual levels which means roughly 4-5 visuals and summary cards but two visuals layers could be also used which means 3-4 visuals and summary cards. Layout has more length in vertical aspect than in width. The report has great points of showing quite detailed and summarized information in same package however it is not suitable for one page overview for many KPIs but rather of showing one KPI and its factors.

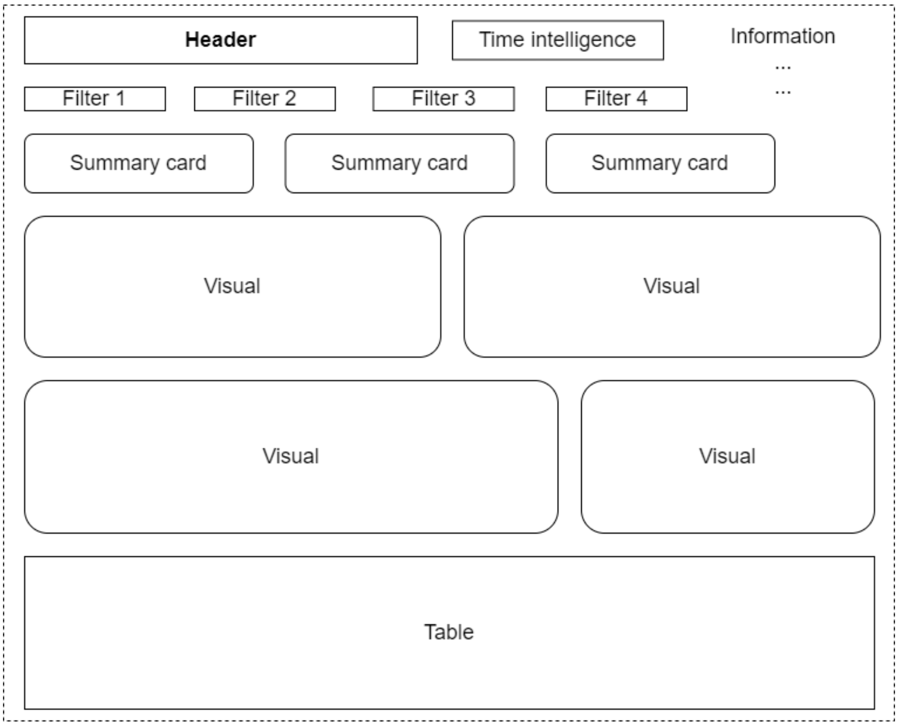

Figure 11. Power BI report KPI layout example with three visual levels

Power BI report starts with header that is with larger font size compared to others. Next to it in right would be time intelligence options equal to time filter where user picks time window, for example this year, last year, this month and so on. Information note is for one or two lines of text that could describe what is important to notice or to do in the report from end-user perspective. Filters would enable user to dive smaller data points and specified views which might have different results. Summary cards works as name suggest having the information in single value while visuals below divide the data to different views, for example monthly values.

If taking the *Rejected Batches [%]* KPI as an example the header would the KPI name usually. Filters could be Product, Manufacturing site / line and similar that is relevant. First summary card on left would have the main KPI as percentage while the other cards could have number of batches rejected and total batches produced. Other cards could also have time-based values like month-to-date (MTD) or year-to-date (YTD). Left visual should always have most important data as humans tend to read from left to right, this applies to visuals also. First main visual shows the KPI (%) as monthly rate while next to it visual could show number of rejected batches as monthly value. Other visual can include like *Rejected Batches [%]* per manufacturing site or line. Table visual would consist of having the same information but per product.

Dashboard in Power BI is in cloud service existing single page view which can be built from one or multiple reports. Users pin visuals from reports to create a consolidated dashboard. (Microsoft 2023d) This feature is very helpful when combining visuals from multiple reports to one page view. No need for recreation of certain visuals to a new report. An example how a dashboard having many KPIs would function is presented in Figure 12 below.

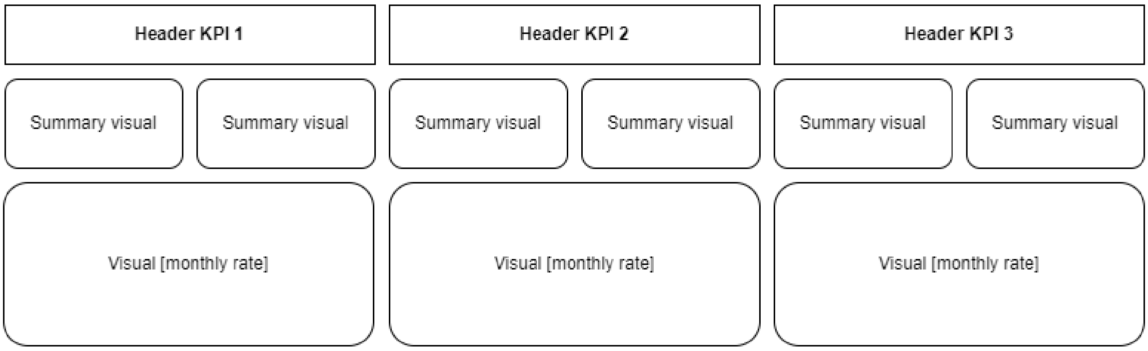

Figure 12. Power BI dashboard layout example

Case company should use Power BI reports for KPIs in general at departmental level while dashboards are better solution of combining departments into business unit views. Dashboards can be also used for summarising many reports into one page view even without relation to departments or unit KPIs.

7 Conclusions

Leading and driving performance management forward without KPIs is impossible. Objectives must be decided before KPIs can be allocated under them which also means that KPIs are hard to use without objectives to relate. KPIs assist and inform progress from certain object or area but it is with management's control to use metrics in his/hers best knowledge to make data driven decisions rather than solely relying on intuition. KPIs might often leave gaps between objects and "stories" are not complete, then managers need to fill those gaps with practical information that they have acquired along the years of working in the organization.

Creating a KPI and reporting framework as a process is quite unique and specifies to the selected area or object. Generally information about industrial fields are available but they rarely offer concrete details from Key Performance Indicators. Finding sources from pharmaceutical industry related to performance management and KPIs was challenging which makes sense because companies are very anxious about giving their information to the public. In pharma drugs are developed in tens of years' time and processes getting market approval from authorities are intense. No business wants to freely give away their competitive advantage even if it became in form of small bits of info. Pharmaceutical industry has long patents lifetime that provide safety against competitors but still publishing KPIs and metrics seem far away. Public limited liability companies has to publish their financial numbers but this is usually restricted to financial numbers only.

In pharma with daily operations like manufacturing and quality control taking a lot of attention from resources and people, "extra" systems for example business intelligence might not be in first of line when improvement of processes and technology occurs. This will lead to usage of excels and other manual type of tools which are vulnerable for errors in input and human memory to updated them on timely manner. Automated KPIs and reporting will bring benefits with increase in data quality due to removing manual input phase and using data sources databases directly. Usually if in data warehouse and analysis all transformations and inquiries are done properly first time with documentation, they rarely offer large problem later on. Small modifications and corrections might be needed especially if source system is misused which causes breakdowns, for example in data relationships and lookup values.

Generally business intelligence system builds fundamentals of KPI and reporting which means that new technologies like artificial intelligence is possible to add and take advantage if needed. AI is useful in finding small differences, forecasting and finding causalities. New technologies are usually able to add later on the system if fundamentals in BI are solid and scalable. Cloud systems are becoming more powerful every year and businesses can find integrations benefits between Microsoft's 365 infra and BI solutions like Power BI service. Transitioning the whole data and analytics infrastructure to the cloud offers usually simple and painless procedures to grow resources and capacity to match organization's needs and requirements.

This research's KPI and reporting framework suggestion reflects the case company needs and theoretical findings. Case study method can be leaning towards researcher's opinion which is why the criticism of case studies are presented. Building the KPI framework takes account interviews that have been constructed from single company which is small sample group and decrease the reliability of using this research in any other business case. Eventhough interviewees were chosen carefully to be managers, interviews itself transcribed and accurately documented, the results which are summarised in this research paper are indication of researcher's interpretation what were takeaways and significant information from the interviews. This affected on what is seen in the KPI framework hence there are a lot of support from literature to valid the KPI framework. The decision of implementing the framework wasn't part of the scope.

There are rarely one way of designing and developing a KPI and reporting framework which implies that more studies about KPI framework usage in performance management is needed. This type of research hopefully would have high number of case company participants from pharmaceutical industry. KPI framework would include what type of metrics were used in what purpose and management level. There could be info about single KPIs used and how have they been formulated to match KPI's goal. This research would create unified measures that could be implemented to the FDA's effort of seeking information between manufacturing and quality management practises. Ultimately FDA could require companies to have certain KPIs from FDA's decided list which would likely apply to the highest organizational level.

8 Summary

This research focused on developing performance measures and management in pharmaceutical industry. The work had two parts: theoretical and empirical. The theoretical part included literature from performance management, building and controlling KPIs, and common metrics from pharmaceutical industry. These sources supported the empirical part that was concluded using case study method. First theoretical chapter dives to performance management especially in data driven time which means perspective was to get latest information how is performance management working when data volumes and sources are increased. Second theoretical chapter has output of creating and managing KPIs using controlled process. KPI must be under strategic objective and documented correctly. Last theoretical chapter focuses on findings from metrics used in pharmaceutical industry which governs mostly quality related KPIs but are still allocated according to functional unit where major contribution against the metric is achieved.

Empirical case part had company interviews, and KPI and reporting framework as results. Eleven managers were interviewed from single company in pharma that gave knowledge about management in performance measuring. Interview section outcome was answers from the interview questions which had significant impact on the KPI and reporting framework. Important pick-ups from interviews were: objectives should be clear, KPIs should be aligned more against objectives, more measures should be added and some of current one redefined, higher visibility towards different metrics is preferred, and automated tools are needed. As positive, objectives and KPIs were in improvement pipeline, more people were using KPIs and wanted to share them, and some had implemented automated reporting like Power BI instead of manual input excels.

Case part finished with creating a KPI & reporting framework suggestion that included implementation plan and, layouts examples for reports and dashboards. Framework consisted of five modules, info screens, quality metrics, department KPIs, business unit dashboards, and organizational KPIs, that were divided by summarization of data and expected viewing recurrence. Info screens and business unit dashboards would display visuals copied from other modules while rest of modules are built from start. Quality metrics were divided to open issues and trending, while important departments got a list of KPIs suggestion for usage. Implementation of the framework would happen using BI system and Power BI that could have slightly distinct directions based on what are organization resources and current system. Case has also Power BI report and dashboard layout examples which should be utilized in KPIs and reporting.

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Appendix 1. Balanced Scorecard example for bank (Anand 2016, 28)

Perspective	Obj. #	Objective		Measure	Unit	Freq.	Objective Owner	MTD Actual	MTD Target	YTD Actual	YTD Target
FINANCIAL	F1	Grow profitable revenues	1	Net profit as % of total commercial income	%	M	CEO				
			2	Commercial income growth	%	M	CEO				
	F2	Increase non-interest income	1	Non-interest income as % of total income	%	M	CEO				
	F3	Increase assets through utilization & acquisition of select corporate customers	1	Growth in funded assets book	%	M	CEO				
			2	New select corporate customers acquired	No.	Q	Head – Corporate Banking				
	F4	Streamline credit	1	Average turnaround time of approval	Days	Q	CRO				
	F5	Improve operating efficiency	1	Oper. cost as % of total commercial income	%	M	COO				
CUSTOMER	C1	I perceive ABC as a bank with strong reputation	1	Customer Index	Index	Y	Head – Retail & Corporate Banking				
	C2	Receive high-quality service consistently	1	Customer Satisfaction Index	Index	Y	Head – Retail & Corporate Banking				
	C3	Receive quality advise	1	Funded Utilization	%	Q	CRO				
			2	Average RM calls per customer	No.	Q	Head – Branches				
	C4	Receive a wide range of non-banking competitive products	1	Customer Index	Index	Y	Head – Retail & Corporate Banking				
	C5	Receive online transactional banking	1	New online services launched	No.	HY	Head – Channels				
			2	Customer Satisfaction Index	Index	Y	Head – Retail & Corporate Banking				
INTERNAL PROCESS	I1	Introduce new products, and selling systems	1	% revenue from new products	%	Y	Head – Retail & Corporate Banking				
			2	Revenue from sales of retail products	USD	Q	Head – Retail Banking				
	I2	Realign the credit processes	1	KMS for streamlining credit	No.	M	CRO				
	I3	Centralize commercial banking operations	1	KMS for organization restructuring	No.	M	CEO				
	I4	Use social/global economic, market, and industry research	1	KMS for research cell setup	No.	M	CRO				
			2	Research reports made available	No.	Q	CRO				
	I5	Encourage customers to move on to lower cost channels	1	% of total transactions done through electronic channels	%	M	Head – Channels				
			2	Education/Communication exercises to customer	No.	Q	Head – Channels				
	I6	Improve productivity and efficiency	1	Accounts exited/transferred to Retail as % of total accounts	%	Q	CEO				
LEARNING & GROWTH	L1	Implement a transparent & objective PMS	1	KMS for performance management system	No.	M	HR HEAD				
	L2	Ensuring training to all staff	1	Training man days per FTE	No.	Y	HR HEAD				
	L3	Clearly define the new organization structure	1	KMS for organization restructuring	No.	M	CEO				
	L4	Improve career and succession planning	1	Employee satisfaction survey	Index	Y	HR HEAD				
			2	Revenue per employee	USD	Y	CEO				
			3	Employee Turnover	%	Y	HR HEAD				
	L5	Improve MIS & leverage knowledge enabled system	1	User Requests	No.	M	Head – IT				
			2	New MIS Reports Available	No.	Q	Head – IT				